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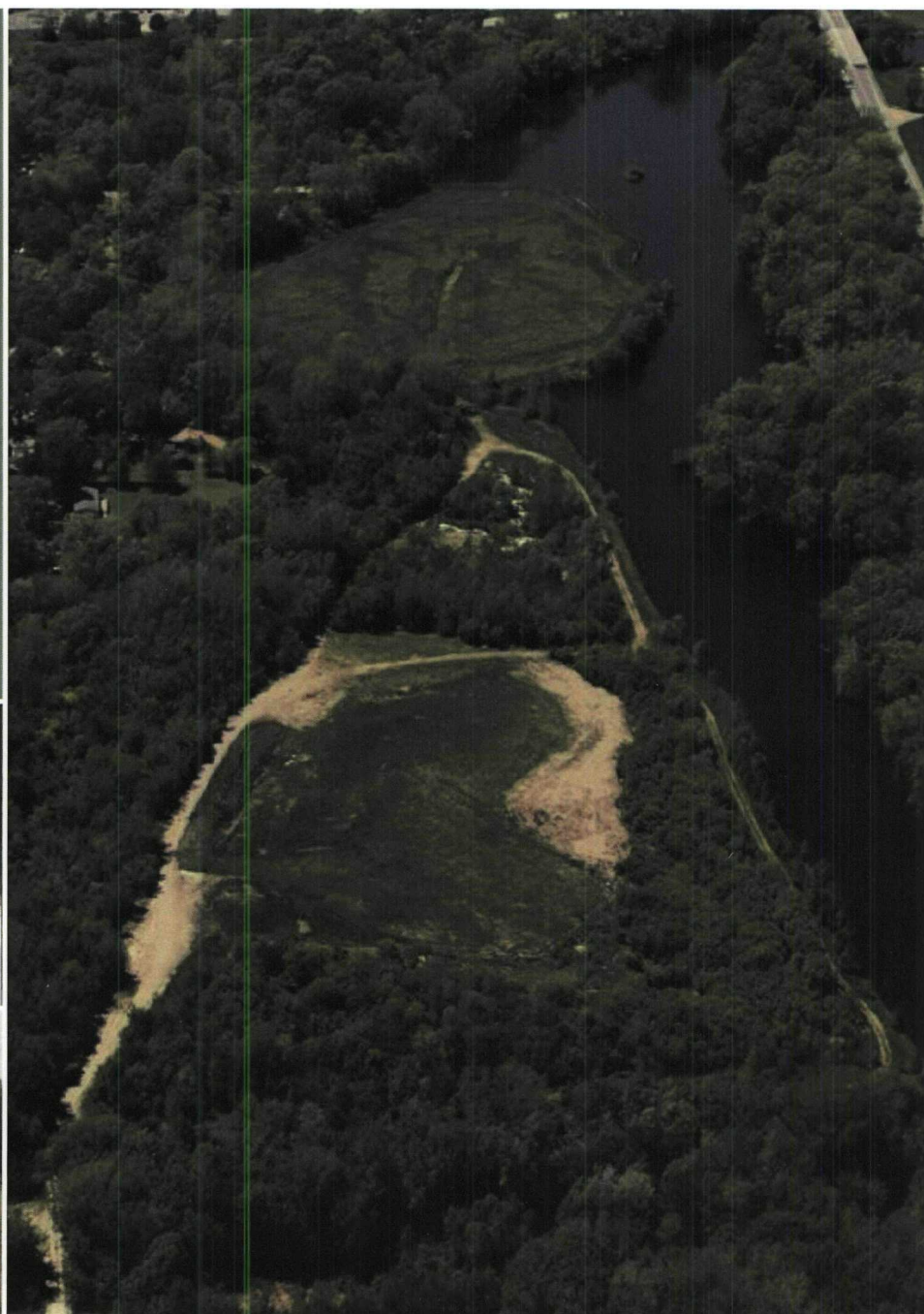
**Allied Paper, Inc./Portage  
Creek/Kalamazoo River  
Superfund Site**

**Willow Boulevard/A-Site  
Landfill Operable Unit 2**

**Final Remedial  
Design  
Specifications**

Georgia-Pacific LLC

May 2011



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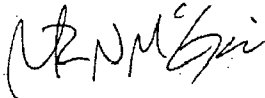
**Willow Boulevard/A-Site Landfill  
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Specifications**

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ARCADIS



Patrick N. McGuire  
Project Coordinator



William Rankin, P.E.  
Engineer of Record

**Final Remedial Design  
Specifications**

Allied Paper, Inc./Portage Creek/  
Kalamazoo River Superfund Site

Willow Boulevard/A-Site Landfill  
Operable Unit

Prepared for:  
Georgia-Pacific LLC

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B0064581 and B0064582

Date:  
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### **DIVISION 1 - GENERAL REQUIREMENTS**

SECTION 01571	Erosion and Sediment Control	01571-1
SECTION 01600	Material and Equipment	01600-1
SECTION 01720	Construction Surveying	01720-1

### **DIVISION 2 – SITE CONSTRUCTION**

SECTION 02072	Linear low density polyethylene Geomembrane	02072-1
SECTION 02073	Geosynthetic Drainage Composite	02073-1
SECTION 02076	Geotextile	02076-1
SECTION 02131	Decontamination and Wipe Sampling of Equipment	02131-1
SECTION 02207	Restoration of Surfaces	02207-1
SECTION 02232	Clearing and Grubbing	02232-1
SECTION 02240	Dewatering and Water Treatment	02240-1
SECTION 02311	Residuals Consolidation	02311-1
SECTION 02315	Excavation and Backfill	02315-1
SECTION 02317	Trenching	02317-1
SECTION 02320	Fill Materials	02320-1
SECTION 02372	Riprap	02372-1
SECTION 02522	Well Installation	02522-1
SECTION 02526	Well Abandonment	02526-1
SECTION 02551	Polyvinyl Chloride (PVC) Pipe	02551-1
SECTION 02618	High-density polyethylene Pipe and Fittings	02618-1
SECTION 02820	Galvanized Chainlink Fence	02820-1
SECTION 02921	Restoration Plantings	02921-1
SECTION 02922	Vegetative Soil, Seeding, and Mulch	02922-1



## SECTION 01571

### EROSION AND SEDIMENT CONTROL

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary for the installation of erosion and sediment control materials (e.g., silt fencing, silt curtain and erosion control mat) as specified in the Project Documents and as requested by the Engineer.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. D3786 Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
  - 2. D3787 Standard Test Method for Bursting Strength of Textiles-Constant-Rate-of-Traverse (CRT) Ball Burst Test
  - 3. D4355 Standard Test Method for Deterioration of Geotextiles by exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus
  - 4. D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity
  - 5. D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
  - 6. D4632 Standard Test Method for Grab Break Load and Elongation of Geotextiles
  - 7. D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
- B. Guidebook for Best Management Practices for Michigan Watersheds, Michigan Department of Natural Resources, Water Quality Division
- C. Michigan Act 451: Natural Resources and Environmental Protection Act (Part 91) [former Michigan Act 347: Soil Erosion and Sediment Control Act]
- D. Michigan Department of Transportation (MDOT) Standard Specifications for Construction (Sections 910 and 916)

## 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

## 1.4 SUBMITTALS

- A. The Contractor shall submit the following information to the Owner and the Owner's Representative:
  - 1. Erosion and Sediment Control Plan (ESCP): The contractor shall prepare an ESCP that conforms with the Project Documents (specifically, this specification and the Construction Drawings) and shall at a minimum adhere to the Guidebook for Best Management Practices for Michigan Watersheds and Michigan Act 451 Part 91. The Contractor shall submit the ESCP to the Engineer for review and approval.
  - 2. Written certification that the delivered materials (e.g., silt fencing, silt curtain and erosion control mat) meet the manufacturer's specifications.
  - 3. The lot/roll numbers for the silt fencing and silt curtain material delivered to the site.
  - 4. Silt Fencing submittal shall include the following:
    - a. Manufacturer's data for geotextile, including at a minimum, physical properties, packaging, and installation techniques;
    - b. Manufacturer's quality assurance/quality control program;
    - c. Manufacturer's quality control test results;
    - d. Physical properties of proposed stakes/posts; and
    - e. Manufacturer's standard warranty for the geotextile.
  - 5. Silt Curtain submittal shall include the following:
    - a. Manufacturer's data for geotextile, including at a minimum, physical properties, packaging, and installation techniques;
    - b. Manufacturer's quality assurance/quality control program;
    - c. Manufacturer's quality control test results;
    - d. Physical properties of proposed stakes/posts; and
    - e. Manufacturer's standard warranty for the geotextile.

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6. Erosion Control Mat submittal shall include the following:
  - a. Manufacturer's data for erosion control mat, including at a minimum, physical properties, packaging, and installation techniques;
  - b. Manufacturer's quality assurance/quality control program;
  - c. Manufacturer's quality control test results; and
  - d. Proposed staple pattern.

- B. The Contractor shall notify Kalamazoo County of proposed erosion and sediment control measures and ensure that all substantive requirements of local permit(s) are met.

## 1.5 WARRANTY

- A. The silt fence and silt curtain manufacturers shall furnish a standard written warranty against defects in the geotextile material and workmanship to the Owner and the Owner's Representative.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Silt Fence and Silt Curtain

Propex  
6025 Lee Highway, Suite 425  
PO Box 22788  
Chattanooga, TN 37422  
1.800.621.1273

Geo-Synthetics, LLC.  
2401 Pewaukee Road  
Waukesha, WI 53188  
1.800.444.5523

- B. Erosion Control Mat

North American Green  
5401 St. Wendel-Cynthiana Road  
Poseyville, IN 47633  
1.800.772.2040

Geo-Synthetics, LLC.  
2401 Pewaukee Road  
Waukesha, WI 53188  
1.800.444.5523

- C. Alternative manufacturers may be considered. The Contractor shall submit the alternate material to the Engineer for review.

### 2.2 MATERIALS

- A. Silt Fence

1. The silt fence fabric shall be free of any chemical treatment that reduces permeability and shall be inert to chemicals commonly found in soil.

## 2. Fabric

- a. The silt fence fabric shall consist of long-chain polymeric fibers or filaments composed of polypropylene. The fibers must be composed of at least 95% propylene or ester polymers.
- b. The silt fence fabric must be a minimum height of 36 inches.
- c. The silt fence fabric shall have the minimum physical properties listed below:

Property	Unit of Measure	Test Method	Value
Grab Tensile	pounds (lbs)	ASTM D4632	100
Grab Elongation	percent (%)	ASTM D4632	40 (maximum)
Trapeziodal Tear	lbs	ASTM D4533	45
UV Resistance	%	ASTM D4355	70 @ 500 hours
Permittivity	sec <sup>-1</sup>	ASTM D4491	0.1
Apparent Opening Size	millimeter (mm)	ASTM D4751	0.6 (maximum)

## 3. Posts

- a. The silt fence posts shall be composed of No. 2 common grade hardwood.
- b. Posts must be of sufficient length and cross-section to support the installed silt fence under full sediment load. At a minimum, posts shall have a cross-sectional area of 2.25 square inches and a height of 48 inches.
- c. Posts shall be spaced a maximum distance of 10 feet.

## B. Silt Curtain

1. The silt curtain shall be a pre-assembled system including floatation mechanisms, geotextile/geomembrane, bottom weights, securing/tie-off mechanism and joining mechanism.
2. Fabric
  - a. The silt curtain fabric shall be constructed of mechanically-bound, non-woven material consisting of long-chain polymeric fibers or filaments composed of polypropylene. The fibers must be composed of at least 95%

propylene or ester polymers. The fibers shall be produced in a manner which achieves a stable network.

- b. The silt curtain fabric shall have the minimum physical properties listed below:

Property	Unit of Measure	Test Method	Value
Grab Tensile	lbs	ASTM D4632	200
Grab Elongation	%	ASTM D4632	50
Trapeziodal Tear	lbs	ASTM D4533	75
Puncture Strength	lbs	ASTM D3787	100
Mullen Burst	pounds per square inch (psi)	ASTM D3786	350
UV Resistance	%	ASTM D4355	70 @ 150 hours
Permittivity	sec <sup>-1</sup>	ASTM D4491	1.3
Apparent Opening Size	mm	ASTM D4751	0.210 (maximum)

### 3. Posts

- a. The silt curtain posts shall be as required.
- b. Posts shall be spaced as required.

### 4. Support Cables

- a. The silt curtain support cables shall be as recommended by manufacturer.

### 5. Chain Anchor

- a. The silt curtain chain anchor shall be as recommended by manufacturer.

## C. Erosion Control Mat

### 1. Temporary Mat

- a. The erosion control mat shall a machine-produced mat of 100% biodegradable blanket of 100% agricultural straw matrix with a functional longevity of up to 12 months.

- b. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the blanket.
- c. The top and bottom of the blanket shall be covered with 100% biodegradable woven natural fiber netting with an approximate 0.50 inch by 1.00 inch mesh.
- d. The blanket shall be sewn together on 1.50 inch centers with biodegradable thread.
- e. The temporary erosion control mat shall be North American Green S150BN or an approved equal.

## 2. Permanent Mat

- a. The erosion control mat shall be a machine-produced blanket of 70% straw/30% coconut fiber matrix, stitch bonded between a heavy duty UV-stabilized top and bottom netting, and an ultra heavy duty UV-stabilized intermediate netting,
- b. The top, intermediate and bottom netting shall have 0.50 inch by 0.50 inch openings.
- c. The blanket shall consist of straw and coconut fibers with minimum unit weights of 0.35 and 0.15 pounds per square yard (lbs/yd<sup>2</sup>), respectively.
- d. The top and bottom of the blanket shall be covered with heavy duty UV-stabilized polypropylene netting with an approximate unit weight of 5.0 pounds per 1,000 square feet (lbs/1,000 ft<sup>2</sup>).
- e. The intermediate netting shall be a corrugated ultra heavy duty UV-stabilized polypropylene netting with an approximate unit weight of 24 lbs/1000 ft<sup>2</sup>.
- f. The blanket shall be sewn together on 1.50 inch centers with UV-stabilized polypropylene thread to form a permanent three-dimensional erosion control mat.
- g. The permanent erosion control mat shall be North American Green SC250 or an approved equal.

## 2.3 MANUFACTURING QUALITY CONTROL

- A. The Contractor shall submit written certification that the delivered materials meet the manufacturer's specifications.

## 2.4 TRANSPORTATION

- A. Transportation of the erosion and sediment control materials shall be the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to and during transportation to the site.



## 2.5 HANDLING AND STORAGE

- A. Handling, storage, and care of the erosion and sediment control materials prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the final cover system.
- B. The Contractor shall be responsible for storage of the erosion and sediment control materials at the site. During storage, the erosion and sediment control materials shall be protected from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. They shall be stored in accordance with the manufacturer's specifications.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. The Contractor shall install erosion and sediment control materials in accordance with the manufacturer's specifications and the approved ESCP.
- B. At a minimum, the erosion and sediment control materials shall be installed at the locations specified in the Project Documents. Additional locations may be identified by the Engineer and/or Contractor prior to, during, and after performance of the construction work based on the need to responsibly management conditions that could lead to soil erosion.

### 3.2 REPAIR

- A. Damaged erosion and sediment control materials shall be repaired in accordance with the manufacturer's specifications.

### 3.3 MAINTENANCE

- A. Maintenance activities shall be conducted in accordance with the approved ESCP.
- B. At a minimum, the erosion and sediment control materials shall be inspected immediately after each rainfall and several times during prolonged rainfalls.
- C. Materials that decompose or become ineffective prior to satisfactory stabilization of the affected up-slope area should be removed and replaced with new materials.
- D. The erosion and sediment control materials shall remain in-place and shall be continually maintained until the Engineer determines that the up-slope areas are stabilized.

END OF SECTION

## SECTION 01600

### MATERIAL AND EQUIPMENT

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary to complete the project as specified in the Project Documents.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in these Specifications, and in the Project Documents.

##### 1.3 SUBMITTALS

- A. The Contractor shall submit the following to the Owner and the Owner's Representative:
  - 1. A complete list of major equipment and materials proposed for use within 15 days after Notice to Proceed has been issued. The list shall include (at a minimum) the name of manufacturer, trade name and model number of each item.
  - 2. Proposed off-site disposal location for materials not approved for on-site disposal.
  - 3. Written independent structural evaluations of the bridge that crosses Davis Creek and the bridge between the Willow Boulevard Landfill and A-Site landfill that determine the suitability of the bridges for the proposed major equipment that will need to cross it. Additionally, the Contractor shall evaluate the roads that will be used to access the site and shall notify the Owner and the Owner's representative of the roads' suitability in providing unhampered access to the site prior to mobilization.

#### PART 2 PRODUCTS

##### 2.1 MATERIALS AND EQUIPMENT

- A. The Contractor shall provide all materials and equipment required to complete the project.
- B. Materials and equipment may include existing materials or components required for reuse.
- C. Materials and equipment removed from existing structures or systems shall not be reused, except where specified in the Project Documents, or allowed by the Engineer.

## 2.2 TRANSPORTATION

Transportation of materials and equipment to the site shall be the responsibility of the Contractor. The Contractor shall be liable for all damages incurred prior to and during transportation of materials and equipment to the site.

- A. Upon delivery to the site, the Contractor shall promptly inspect shipments to ensure that the type and quantity of shipped material meets the requirements provided in these Specifications and the Project Documents.
- B. Off-site transportation of materials to an approved disposal facility shall be the responsibility of the Contractor. The Contractor shall be liable for all damages incurred during off-site transportation of materials.

## 2.3 HANDLING AND STORAGE

- A. Handling, storage and care of the materials and equipment prior to and after project completion, shall be the responsibility of the Contractor.
- B. Materials shall be stored in accordance with manufacturer's instructions, with seals and labels intact and legible. The Contractor shall periodically inspect materials to ensure products are undamaged and are maintained.
- C. Fabricated materials stored on-site shall be covered with impervious sheet covering. Adequate ventilation shall be provided to prevent condensation.
- D. *Loose granular materials shall be stockpiled on solid surfaces in a well drained area of the site.* The Contractor shall prevent mixing of foreign matter with loose granular material.
- E. The Contractor shall periodically inspect materials to ensure that they are maintained in accordance with these Specifications and remain undamaged.

## 2.4 DISPOSAL

- A. Materials not approved for on-site disposal shall be shipped to an off-site facility. The Contractor shall propose an off-site disposal facility to the Owner for review and approval, as mentioned in Section 1.3 of this Specification.
- B. The Contractor shall arrange for materials to be shipped off-site in an appropriate manner and in accordance with State and Federal guidelines and requirements.

## 2.5 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: The Contractor may use any product meeting those standards.
- B. Products Specified by Naming One or More Manufacturer with a Provision for Substitutions: The Contractor shall submit a request for substitution of any manufacturer not specifically named.

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- C. Products Specified by Naming Several Manufacturers: No options or substitutions shall be made.
- D. Products of Named Manufacturers Meeting Specifications: No options or substitutions shall be made.
- E. Products Specified by Naming Only One Manufacturer: No options or substitutions shall be made.

## 2.6 SUBSTITUTIONS

- A. The Contractor shall submit any request for substitution to the Engineer for review within 15 days after the Notice to Proceed has been issued. Subsequently, substitutions shall be considered only when a product becomes unavailable through no fault of the Contractor.
- B. The Contractor shall document each substitution request and include information substantiating compliance with the Project Documents.
- C. A request constitutes a representation that the Contractor:
  - 1. Has investigated the proposed product and determined that it meets or exceeds the Specifications in all respects.
  - 2. Will provide the same warranty for the substitution as for the specified product.
  - 3. Will coordinate installation and make any changes necessary to complete the work.
  - 4. Waives claims for additional costs which may subsequently become apparent.
- D. The Engineer shall not consider indicated or implied substitutions on shop drawings or product data submittals until a separate written substitution request from the Contractor has been received and reviewed.
- E. The Engineer shall determine whether a proposed substitution is acceptable and will notify the Contractor of acceptance or rejection in writing within a reasonable time.
- F. The Engineer shall consider only one request for substitution for each product. When a substitution is not accepted, the Contractor shall use the product specified in Project Documents.

## PART 3 EXECUTION

NOT USED

END OF SECTION

## SECTION 01720

### CONSTRUCTION SURVEYING

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall safeguard all survey points and bench marks. The replacement costs for any destroyed survey points or benchmarks shall be borne by the Contractor. The Contractor shall assume the entire expense of rectifying work improperly constructed due to failure to maintain and protect such established survey points and bench marks.
- B. The Contractor shall be responsible for the layout of any additional survey controls, grid coordinate locations, lines, grades, and elevations necessary for the proper construction and testing of the work called for by the Project Documents at no additional cost to the Owner. Survey activities shall include, but not be limited to achieving and maintaining specified and appropriate locations, lines, grades and thicknesses.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification and in the Project Documents.
- B. The Contractor shall verify locations of survey control points prior to starting work. If any discrepancies are identified, the Contractor shall promptly notify the Engineer to determine the appropriate course of action.
- C. The Contractor shall employ a Michigan licensed land surveyor to provide the surveying functions necessary for the proper construction and documentation of the work.

##### 1.3 SUBMITTALS

- A. Upon request, the Contractor shall submit the following information to the Owner and the Owners Representative:
  - 1. Qualifications of the land surveyor.
  - 2. Documentation verifying the extent and accuracy of the survey work.
  - 3. A complete and accurate log of survey work performed throughout the project duration.

4. As-built surveys as described in Section 3.2 of this Specification.
  - a. As-built surveys shall be submitted directly from the surveyor to the Engineer in electronic format (acceptable format to be determined in coordination with the Engineer).

## PART 2 PRODUCTS

NOT USED

## PART 3 EXECUTION

### 3.1 SURVEYING AND FIELD ENGINEERING SERVICES

- A. The Engineer shall identify permanent benchmarks.

### 3.2 CONTRACTOR SURVEY REQUIREMENTS

- A. The Contractor shall provide as-built survey information throughout the duration of the project. The as-built survey data shall be accurate to within 0.1 feet, provided in State Plane coordinates (North American Datum of 1983) based on the National Geodetic Vertical Datum of 1929 (feet above mean sea level), and include the following information:
  1. Top of residuals/bottom of gas venting layer elevations on a maximum 50-foot grid. The as-built survey shall include grade breaks and the limits of the gas-venting layer.
  2. Top of the 12-inch thick gas venting layer including grade breaks, toes of slope, and tops of slope. The minimum acceptable gas venting layer thickness shall be 12 inches (+/- 0.1 feet).
  3. Geomembrane installation, including the completed limits of installed geomembrane, repair locations, and destructive testing locations.
  4. Top of the 24-inch thick soil protection layer including grade breaks, toes of slope, and tops of slope. The minimum acceptable soil protection layer thickness shall be 24 inches (+/- 0.1 feet).
  5. Top of the 6-inch thick vegetative soil layer, including grade breaks, toes of slope, and tops of slope. The minimum acceptable vegetative soil layer thickness shall be 6 inches (+/- 0.1 feet).
  6. Top of the access road general fill layer every 50 feet around the perimeter of the landfill.
  7. Top of the access road aggregate layer. The minimum acceptable access road aggregate layer thickness shall be 8 inches (+/- 0.1 feet).



8. Bottom of vegetative soil layer at the top and toe of slope within the riparian corridor as shown on the Construction Drawings.
  9. Top of vegetative soil layer at the as-built elevations for the bottom of the topsoil within the riparian corridor. The minimum acceptable topsoil thickness within the riparian corridor shall be 12 inches (+/- 0.1 feet) as shown on the Construction Drawings. All other areas of vegetative soil shall be 6-inches thick as indicated in Section 3.2 (A)(5) of this Specification.
  10. Pipe invert elevations every 50 linear feet (where applicable) and at changes in direction, grade breaks, intersections and end points.
  11. Final limits and depths of excavations associated with perimeter excavation areas as shown on the Construction Drawings.
  12. Locations of all monitoring wells, gas vents and final cover collection pipe outlets.
  13. Limits of all riprap, habitat stone and restoration/mitigations areas.
- B. Soil layer thicknesses may be determined from as-built survey information.
- C. The Contractor shall inspect survey points and bench marks between surveys to verify that they have not been altered or destroyed.

END OF SECTION

## SECTION 02072

### LINEAR LOW DENSITY POLYETHYLENE GEOMEMBRANE

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Geosynthetics Installer shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary for the installation of the geomembrane as specified in the Project Documents. The Geosynthetics Installer shall be under direct contract to the Contractor.
- B. The Geosynthetics Installer shall be prepared to install the geomembrane in conjunction with earthworks and other components of the final cover system.
- C. The Geosynthetics Installer will install the geomembrane and provide testing services for all installed geomembrane.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. D792 Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
  - 2. D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
  - 3. D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
  - 4. D1248 Standard Test Method for Polyethylene Plastics Molding and Extrusion Materials
  - 5. D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
  - 6. D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
  - 7. D4437 Standard Test Method for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
  - 8. D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
  - 9. D5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

10. D5397 Standard Test Method for Single-Point Notched Constant Load Test
  11. D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
  12. D5994 Standard Test Method for Measuring the Core Thickness of textured Geomembranes
  13. D6392 Standard Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- B. D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes Geosynthetic Research Institute (GRI):
1. GM 6 Standard Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes
  2. GM 12 Asperity Measurement of Textured Geomembranes Using a Depth Gage
  3. GM 17 Test Methods, Test properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
  4. GM 19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

## 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor and the Geosynthetics Installer shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

## 1.4 QUALIFICATIONS

### A. Contractor:

1. The Geosynthetics Installer will be contracted directly by the Contractor. The Geosynthetics Installer shall meet the qualification requirements of this specification.

### B. Geomembrane Manufacturer:

1. The Geomembrane Manufacturer shall be responsible for the production of geomembrane rolls from resin and shall have sufficient production capacity and

qualified personnel to meet the demands (e.g., quantity production, and quality control) of this project.

2. The Geomembrane Manufacturer shall have at least 5 years of continuous experience in manufacturing LLDPE geomembrane and have produced 10,000,000 square feet (minimum) of LLDPE geomembrane and installed at least 8,000,000 square feet.

C. Geosynthetics Installer:

1. The installer of the geomembrane shall be the Geosynthetics Installer who shall be responsible for field handling, storing, deploying, seaming, temporarily restraining (against wind), and other site aspects of the LLDPE geomembrane and other components of the final cover system.
2. The Geosynthetics Installer shall have at least 5 years of continuous experience in installing polyethylene geomembrane and have installed 5,000,000 square feet (minimum) of polyethylene geomembrane for at least 10 completed facilities.
3. Personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience in seaming 1,000,000 square feet (minimum) of polyethylene geomembrane using the same type of seaming apparatus to be used on this project. The most experience seamer, called the "master seamer," shall provide direct supervision, as required, over less experienced seamers.
4. The laboratory used by the Geosynthetics Installer for laboratory testing of destructive seam samples shall have extensive experience with all types of geosynthetics and be accredited members of the Geosynthetics Accreditation Institute – Laboratory Accreditation Program (GAI-LAP).

D. Conformance Testing and Interface Friction/Direct Shear Testing Laboratory

1. An independent laboratory contracted directly by the Owner, shall be used for conformance testing and interface friction/direct shear testing as required by this specification. The Conformance Testing Laboratory shall have extensive experience with all types of geosynthetics and be accredited members of the GAI-LAP.

## 1.5 SUBMITTALS

- A. The following items shall be submitted no later than 30 days prior to the start of geomembrane installation or 15 days prior to delivery of the first geomembrane shipment, whichever is earliest.
  1. The Geomembrane Manufacturer shall submit the following information in writing to the Owner and the Owner's Representative:
    - a. Corporate background and information.

- b. Manufacturing Quality Control (MQC) Plan.
- c. Manufacturing capabilities, including:
  - 1) Information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
  - 2) Daily production quantity available for this Contract;
  - 3) Manufacturing quality control procedures; and
  - 4) List of material properties, including certified test results, attached to which is a geomembrane sample.
- d. A list of at least ten completed facilities for which the Geomembrane Manufacturer has manufactured a minimum of 10,000,000 square feet of polyethylene geomembrane. The following information shall be provided for each facility:
  - 1) Name, location, and purpose of facility, and date of installation;
  - 2) Names of Owner, Project Manager, Engineer, General Contractor, fabricator (if any), and installer; and
  - 3) Type, thickness and quantity of geomembrane manufactured.
- e. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the polyethylene resin.
- f. Copies of quality control certificates issued by the resin supplier.
- g. Results of tests conducted by the Geomembrane Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the project.
- h. Certification that no reclaimed polymer is added to the resin during the manufacture of the geomembrane to be used for this project. The use of polymer recycled during the manufacturing process may be permitted if performed with appropriate cleanliness and if the recycled polymer does not exceed 10% by weight of the total polymer weight.
- i. Manufacturing certificates for each shift's production of geomembrane, signed by responsible parties employed by the Geomembrane Manufacturer (such as the production manager), and notarized.

- j. Quality control certificates providing the results of the quality control tests outlined in Section 2.3(A) of this Specification.
  - 1) The quality control certificates shall include:
    - a) Roll numbers and identification;
    - b) Sampling procedures; and
    - c) Results of quality control tests, including descriptions of the test methods used.
- 2. The Geosynthetics Installer shall submit the following information in writing to the Owner and the Owner's Representative:
  - a. Corporate background and information.
  - b. Copy of installer's letter of approval or license by the Geomembrane Manufacturer and/or fabricator.
  - c. Construction Quality Control (CQC) Plan.
  - d. Installation capabilities, including:
    - 1) Information on equipment and personnel;
    - 2) Average daily production anticipated for this project;
    - 3) Quality control procedures; and
    - 4) Samples of field seams, a certified list of minimum values for seam properties, and the test methods employed.
  - e. A list of at least 10 completed facilities, for which the installer has installed a minimum of 5,000,000 square feet of polyethylene geomembrane. The following information shall be provided for each facility:
    - 1) The name and purpose of the facility, its location, and dates of installation;
    - 2) The names of the Owner, Project Manager, Engineer, General Contractor, Geomembrane Manufacturer, fabricator (if any), and the name of a contact at the facility who can discuss the project;
    - 3) Name and qualifications of the installer's supervisor(s);
    - 4) Thickness and surface area of installed geomembrane;
    - 5) Type of seaming and type of seaming apparatus used; and
    - 6) Duration of installation.



- f. Resumes of all personnel who will perform seaming operations on this project, including dates and duration of employment.
  - g. Resume of the installation supervisor to be assigned to this project, including dates and duration of employment. The superintendent shall have supervised the installation of a minimum of 2,000,000 square feet of polyethylene geomembrane.
  - h. Proposed installation panel layout drawing showing the placement of geomembrane panels, seams and any variances or additional details which deviate from the Construction Drawings.
  - i. Installation schedule.
  - j. The name and qualifications of the proposed laboratory that will be responsible for laboratory testing of destructive seam samples.
- 3. The Contractor shall submit the following information in writing to the Owner and the Owner's Representative:
  - a. Certification that the field-delivered geomembrane has not been damaged due to improper transportation, handling, or storage.
  - b. Certification that the surface on which the geomembrane is to be installed is acceptable to both the Engineer and the Contractor. The certification is subject to the review and approval or rejection by the Owner.
- B. During installation, the Geosynthetics Installer shall submit the following information to the Owner and the Owner's Representative:
  - 1. Subgrade acceptance certificates signed by the installer for each area to be covered by the geomembrane;
  - 2. Daily field logs documenting the work being performed, personnel involved, general working conditions, and any problems encountered or anticipated on the project;
  - 3. Field quality control documentation (i.e., trial seam tests, destructive tests, non-destructive tests, etc.); and
  - 4. A Certificate of Calibration less than 12 months old for the field tensiometer referenced in Section 3.3(H)(2) of this Specification.
- C. Upon completion of the installation, the Geosynthetics Installer shall be responsible for the timely submission of the following:
  - 1. Geomembrane installation certification;
  - 2. As-built panel layout diagram; and

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3. Warranty from Geomembrane Manufacturer/Installer as specified in Section 1.6 of this Specification.

## 1.6 WARRANTY

The Geomembrane Manufacturer and Geosynthetics Installer shall furnish a standard written warranty against defects in material and workmanship. Warranty duration and conditions concerning limits of liability will be evaluated and must be acceptable to the Owner.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

#### A. LLDPE Geomembrane

GSE Lining Technology Inc.  
19103 Gundle Road  
Houston, TX 77073  
1.800.435.2008

Poly-Flex, Inc.  
2000 West Marshall Drive  
Grand Prairie, TX 75051  
1.888.765.9359

- B. An alternate Geomembrane Manufacturer may be considered. The Contractor shall submit the alternate material to the Engineer for review.

### 2.2 MATERIALS

#### A. Polyethylene Geomembrane Resin

1. The resin shall comply with the following LLDPE specified properties:
  - a. Specific Gravity: 0.926 g/ml, maximum (ASTM D792 Method B, or ASTM D1505)
  - b. Melt Index: 1.0 g/10 minute, maximum (ASTM D1238 Condition E 190 °C, 2.16 kg)
2. Resin shall be virgin material with no more than 10% rework (by weight). Rework material shall be of the same formulation as parent material. No post-consumer resin shall be added to the formulation.

#### B. LLDPE Geomembrane

1. The LLDPE geomembrane shall meet the required property values shown below and in Table 02072-1.
2. In addition to the property values listed in Table 02072-1, the geomembrane shall:
  - a. Contain a maximum of 1% (by weight) of additives, fillers, or extenders (not including carbon black);

- b. Be free of striations, pinholes, or bubbles on the surface or in the interior;
- c. Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter; and
- d. Be manufactured in a single layer (thinner layers shall not be welded together to produce the final required thickness) and have a uniform textured appearance on both sides.

#### C. Welding Material

- 1. The resin used in the welding material shall be identical to the liner material.
- 2. All welding materials shall be of a type recommended and supplied by the Geomembrane Manufacturer and shall be delivered in the original sealed containers, each with an indelible label bearing the brand name, Geomembrane Manufacturer's mark number, and complete directions as to proper storage.

#### D. Fabrication

- 1. The geomembrane shall be delivered to the site in rolls or as factory panels. A factory panel is comprised of one or more rolls that have been seamed together in a factory.
- 2. Labels on each geomembrane roll shall identify the following information:
  - a. Name of Geomembrane Manufacturer;
  - b. Product identification;
  - c. Roll number and dimensions;
  - d. Batch number;
  - e. Thickness of the material; and
  - f. Directions to unroll the material.

### 2.3 GEOMEMBRANE TESTING REQUIREMENTS

#### A. Geomembrane Manufacturer's Quality Control Testing

- 1. Polyethylene Geomembrane Resin
  - a. The Geomembrane Manufacturer shall sample and test the resin to demonstrate that the resin complies with this Specification. The Geomembrane Manufacturer shall certify in writing that the resin meets this Specification, and shall be held liable for any non-compliance.

- b. Geomembrane material manufactured from non-complying resin will be rejected. Replacement of any rejected geomembrane material will be at no cost to the Owner.
2. LLDPE Geomembrane
- a. The Geomembrane Manufacturer shall continuously monitor the geomembrane during the manufacturing process for inclusions, bubbles, or other defects. No geomembrane that exhibits any defects will be accepted.
  - b. The Geomembrane Manufacturer shall continuously monitor the geomembrane thickness during the manufacturing process. No geomembrane that fails to meet the specified minimum thickness will be accepted.
  - c. The Geomembrane Manufacturer shall sample and test the geomembrane, in accordance with the MQC Plan to demonstrate that its properties conform to the values specified in Table 02072-1.
    - 1) Samples shall be taken across the entire width of the roll.
    - 2) At a minimum, the following manufacturing quality control tests shall be performed:

Test	Procedure
Thickness	ASTM D5994
Density	ASTM D1505/ ASTM D 792
2% Modulus	D 5323
Break Strength	ASTM D6693 Type IV
Break Elongation	ASTM D6693
Tear Resistance	ASTM D1004
Puncture Resistance	ASTM D4833
Carbon Black Content	ASTM D1603
Carbon Black Dispersion	ASTM D5596
Axi-Symmetric Break Resistance Strain	ASTM D5617
Asperity Height	ASTM D7466
Oxidative Induction Time (OIT)	ASTM D3895/ ASTM D5885
Oven Aging at 85°C	ASTM D5721/ ASTM D3895/ ASTM D5885
UV Resistance	ASTM D5885

- d. Any geomembrane sample that does not comply with this Specification will be rejected by the Owner.
  - e. If a roll of geomembrane is rejected, the Geomembrane Manufacturer shall sample and test each roll manufactured in the same batch or at the same time as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.
  - f. The Contractor shall replace any rejected rolls at no additional cost to the Owner.
  - g. Additional testing may be performed at the Geomembrane Manufacturer's discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.
3. The Geomembrane Manufacturer's test results shall be submitted by the Contractor to the Engineer for review, prior to shipping any rolls of geomembrane.

## B. Conformance Testing

- 1. Prior to installation, samples of delivered geomembrane shall be taken and shipped to a third party testing laboratory (i.e. the Owner's Conformance Testing Laboratory), for conformance testing independent of the manufacturer's testing. Unless otherwise specified, the samples shall be taken at a minimum frequency of one sample per 100,000 square feet with a minimum of one sample per lot of material delivered to the site (regardless of the dates of manufacturing or delivery dates). At least one sample shall also be obtained from geomembrane rolls representing each resin production batch.
- 2. Samples shall be at least 3 feet long by the roll width and shall not include the first 3 feet of any roll.
- 3. Conformance testing shall be the responsibility of the Owner.
- 4. The Contractor shall, at no additional cost to the Owner, provide whatever reasonable assistance the Engineer may require in obtaining the samples for conformance testing.

5. At a minimum, the following conformance tests shall be performed:

Test	Procedure
Thickness	ASTM D5994
Density	ASTM D1505/ ASTM D 792
Break Strength	ASTM D6693 Type IV
Break Elongation	ASTM D6693
Tear Resistance	ASTM D1004
Puncture Resistance	ASTM D4833
Carbon Black Content	ASTM D1603
Carbon Black Dispersion	ASTM D5596
Asperity Height	ASTM D7466

6. Prior to installation, the Engineer shall review the conformance test results against the material properties required by Table 02072-1. Non-conforming material will be rejected and bracketed from subsequent rolls from the same product batch.
7. If geomembrane material is rejected due to failing conformance test results, the Contractor shall be responsible for all costs associate with additional material testing and replacement of materials as necessary.

## C. Interface Friction/Direct Shear Testing

- Prior to installation, samples of delivered geomembrane shall be taken and shipped to the Owner's geosynthetics laboratory for interface friction/direct shear testing.
- Samples shall be at least 3 feet long by the roll width and shall not include the first 3 feet of any roll.
- Interface friction/direct shear testing shall be conducted on the following interfaces:
  - 40 mil textured LLDPE geomembrane versus sand (gas venting layer material); and
  - 40 mil textured LLDPE geomembrane versus geosynthetic drainage composite.
- Soil samples of on-site materials shall be collected by the Engineer for interface friction/direct shear testing.
- Interface friction/direct shear testing shall be the responsibility of the Owner.
- The Engineer shall review the results of the interface friction/direct shear test.



- a. If the Engineer determines that the proposed geomembrane will provide adequate slope stability, and the geomembrane rolls meet all other specifications, the geomembrane rolls shall be accepted.
- b. If the Engineer determines that the proposed geomembrane will not provide adequate slope stability, the geomembrane rolls shall not be accepted.
  - 1) The Contractor shall be responsible for removing all unacceptable geomembrane rolls from the site and replacing them with acceptable material.

## D. Procedures for Determining Geomembrane Roll Test Failures

- 1. For test results reported in both machine and cross direction, results from each direction shall be compared to the acceptable specifications to determine acceptance.
- 2. For test methods requiring multiple samples, the criteria in Table 02072-1 shall be met based on average results of multiple specimen tests.
- 3. The following procedures shall be used for interpreting results:
  - a. If the test results meet the specification values provided in Table 02072-1, then the roll, batch and entire shipment, if applicable, shall be accepted provided the requirements of Section 2.3(A) are met; and
  - b. If the test results do not meet the specification values provided in Table 02072-1, then the roll and batch shall be retested at the Contractor's expense using specimens from the original roll sample or from another sample collected by the Engineer. For retesting, two additional tests shall be performed.
    - 1) If both retest values meet the specification values, then the roll and batch shall be accepted.
    - 2) If one additional test fails, then the roll and batch shall be rejected without further recourse.
      - a) At the Contractor's expense, the Engineer may obtain samples from other rolls within the batch. Based on the test results from these samples, the Engineer may choose to accept a portion of the batch while rejecting the remainder.
      - b) If retesting does not result in passing test results as defined above, or if there is any other non-conformity with the material Specifications, then the geomembrane rolls shall be removed from the site. Once removed from the site, these same rolls shall not be resubmitted for use.

- c) The Contractor shall be responsible for removing all non-conforming geomembrane rolls from the site and replacing with acceptable material.

## 2.4 TRANSPORTATION

Transportation of the geomembrane shall be the responsibility of the Geomembrane Manufacturer. The Geomembrane Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation to the site.

## 2.5 HANDLING AND STORAGE

- A. Handling, storage, and care of the geomembrane prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the final cover system.
- B. The Contractor shall be responsible for storage of the geomembrane at the site. During storage, the geomembrane shall be protected from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane shall be stored in accordance with any additional requirements of the Geomembrane Manufacturer.

## PART 3 EXECUTION

### 3.1 EARTHWORK

- A. Surface Preparation
  - 1. The Geosynthetics Installer shall provide certification in writing that the surface on which the geomembrane will be installed is acceptable. The surface shall be free of stones, litter, organic matter, irregularities, protrusion, loose soil, and any abrupt changes in grade that could damage the geosynthetic. The certification of acceptance shall be given to the Engineer prior to commencement of geomembrane installation.
  - 2. Special care shall be taken to maintain the prepared soil surface.
  - 3. No geomembrane shall be placed onto an area which has been softened by precipitation or which has cracked due to desiccation. The soil surface shall be observed daily to evaluate the effects of desiccation cracking and/or softening on the integrity of the soil liner.
  - 4. Any damage to the soil surface caused by installation activities shall be repaired at the Geosynthetics Installer's expense.
  - 5. The Geosynthetics Installer shall be responsible for dewatering areas that have been accepted for geomembrane deployment, including anchor trenches.

## B. Geosynthetics Anchor Trench

1. The anchor trench shall be excavated prior to geomembrane placement to the lines, grades, and configuration shown on the Construction Drawings.
2. No loose soil shall be allowed in the anchor trench beneath the geomembrane.
3. The anchor trench shall be backfilled and compacted after the geosynthetics have been installed in the trench. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane.
4. Corners where the geomembrane adjoins the trench shall be slightly rounded to avoid sharp bends in the geomembrane.

## 3.2 GEOMEMBRANE DEPLOYMENT

A. Layout Drawings: The Geosynthetics Installer shall produce layout drawings prior to geomembrane deployment. These drawings shall indicate the geomembrane configuration, dimensions, details, locations of seams, etc. Field seams shall be differentiated from factory seams (if any) on the drawings. Field seams shall be oriented up or down slope and not across slope. The layout drawings must be approved by the Engineer prior to the installation of any geomembrane. The layout drawings, as modified and/or approved by the Engineer shall become part of the Project Documents.

## B. Field Panel Identification

1. A geomembrane field panel is defined as follows:
  - a. If the geomembrane is not fabricated into factory panels, a field panel is a roll or a portion of roll cut in the field.
  - b. If the geomembrane is fabricated into factory panels, a field panel is a factory panel or a portion of factory panel cut in the field.
2. Each field panel must be given an identification code (number or letter-number). This identification code shall be agreed upon by the Engineer and Geosynthetics Installer. The field panel identification code shall be related, through a table or chart, to the original resin, and the constituent rolls and factory panels.

## C. Field Panel Placement

1. Field panels shall be installed as approved or modified at the location and positions indicated in the layout drawings.
2. Field panels shall be placed one at a time, and each field panel shall be seamed to adjacent panels the same day that it is placed.
3. Geomembranes shall not be placed when the ambient temperature is below 32°F, unless otherwise authorized by the Engineer.

4. Geomembranes shall not be placed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of winds exceeding 20 miles per hour.
5. The Geosynthetics Installer shall employ placement methods consistent with the following:
  - a. No vehicular traffic shall be allowed on the geomembrane.
  - b. Equipment used shall not damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.
  - c. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.
  - d. The method used to unroll the panels shall not scratch or crimp the geomembrane and shall not damage the supporting soil.
  - e. The prepared surface underlying the geomembrane shall not be allowed to deteriorate after acceptance of the surface, and shall remain acceptable up to the time of geomembrane placement.
  - f. The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).
  - g. Temporary loads and/or anchors (e.g., sand bags, tires) not likely to damage the geomembrane may be placed on the geomembrane to prevent uplift by wind (in high winds, continuous loading is recommended along panel edges to minimize the risk of wind flow under the panels).
6. Any field panel or portion thereof that becomes seriously damaged (torn, twisted, or crimped) shall be replaced with new material at no cost to the Owner. Less serious damage may be repaired at the Engineer's sole discretion and at no cost to the Owner. Damaged panels or portions of damaged panels that have been rejected shall be removed from the work area.

### 3.3 FIELD SEAMING

- A. Seam Layout: In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across, the slope. In corners and at odd-shaped geometric locations, the number of field seams shall be minimized. No horizontal seam shall be made within 5 feet of any toe of the slope, except where approved by the Engineer. No seams shall be located in an area of potential stress concentration, as defined by the Owner.
- B. Personnel: All personnel performing seaming operations shall be qualified as indicated in Section 1.4(C)(3). No seaming shall be performed unless a "master seamer" is present.

## C. Weather Conditions for Seaming

1. Seaming shall not be attempted at ambient temperatures below 32°F or above 104°F or when wind velocity exceeds 20 miles per hour. At ambient temperatures between 32°F and 50°F, seaming shall be allowed if the geomembrane is preheated either by the sun or a hot air device, and if there is no excessive cooling from wind. At ambient temperatures above 50°F, no preheating will be required. In all cases, the geomembrane shall be dry and protected from excessive wind.
2. If the Geosynthetics Installer wishes to use methods that may allow seaming at ambient temperatures below 32°F or above 104°F, he shall demonstrate that the seam so produced is equivalent to those produced under normally approved conditions, and that the overall quality of the geomembrane is not adversely affected. In addition, an addendum to the Contract between the Contractor and the Geosynthetics Installer shall be required. The addendum shall specifically state that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane.
3. To minimize geomembrane contraction stresses, seaming should ideally be carried out in the morning and late evening when the geomembrane is relatively contracted and during the middle of the day if overcast conditions prevail. If the geomembrane must be seamed in the middle of a sunny day, the Geosynthetics Installer shall ensure that the panels to be seamed are at the same temperature and that there is sufficient slack in the geomembrane to prevent the generation of excessive stresses or trampolining when the geomembrane contracts as cooler temperatures prevail. The required amount of slack shall be determined by the Geosynthetics Installer and it should not be so much so as to cause significant wrinkling of the geomembrane. If trampolining of the geomembrane is observed, the Geosynthetics Installer will be required to make repairs so that the problem is eliminated.
4. Ambient temperatures shall be measured 6 inches above the geomembrane surface.

## D. Overlapping and Temporary Bonding

1. Geomembrane panels shall be overlapped a minimum of 3 inches for extrusion welding and 5 inches for fusion welding, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.
2. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane. The temperature of the air at the nozzle of spot welding apparatus shall be controlled such that the geomembrane is not damaged.
3. No solvent or adhesive shall be used unless the product has been approved in writing by the Owner. Samples of any proposed solvent or adhesive shall be submitted to the Engineer for testing and evaluation at the Geosynthetics Installer's expense.

## E. Seam Preparation

1. Prior to seaming, the seam area shall be cleaned and made free of moisture, dust, dirt, debris of any kind, and foreign material.
2. If seam overlap grinding is required, the process shall be completed according to the Geomembrane Manufacturer's instructions within one hour of the seaming operation and in a manner that does not damage the geomembrane. The grind depth shall not exceed 10% of the geomembrane thickness. Grinding marks shall not appear beyond 0.25 inch of the extrudate after it is placed.
3. Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths".

## F. General Seaming Requirements

1. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.
2. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface, directly under the seam overlap to achieve proper support.
3. If seaming operations are carried out at night, adequate illumination shall be provided by the Geosynthetics Installer for performing seaming activities.
4. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed where possible; any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane that extends a minimum of 6 inches beyond the cut in all directions.

## G. Seaming Process

1. Approved processes for field seaming are extrusion welding and fusion welding. Seaming equipment shall be operated in a manner that does not cause damage to the geomembrane. Only apparatus that the Engineer has specifically approved by make and model shall be used. Proposed alternate seaming processes shall be documented and submitted to the Engineer.
2. Extrusion Equipment and Procedures
  - a. The Geosynthetics Installer shall maintain at least one spare operable extrusion seaming apparatus on-site at all times.
  - b. Extrusion welding apparatus shall be equipped with gauges giving the temperature in the apparatus and at the nozzle.
  - c. Prior to beginning a seam, the extruder shall be purged until all heat-degraded extrudate has been removed from the barrel. Whenever the

extruder is stopped, the barrel shall be purged of all heat-degraded extrudate.

- d. The Geosynthetics Installer shall provide documentation regarding the extrudate to the Engineer and shall certify that the extrudate is compatible with the specifications, and consists of the same resins as the geomembrane.
- e. The electric generator used for power supply to the welding machines shall be placed outside the area to be lined or mounted on soft tires such that no damage occurs to the geomembrane. The electric generator shall be equipped with a grounding rod that is driven into the ground outside the lined area. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

### 3. Fusion Equipment and Procedures

- a. The Geosynthetics Installer shall maintain at least one spare operable seaming apparatus on-site at all times.
- b. Fusion-welding apparatus shall be automated vehicular-mounted devices equipped with gauges that show the instantaneous temperatures and pressures of the machine.
- c. The edges of cross seams shall be abraded to a smooth incline (top and bottom) prior to welding.
- d. A movable protective layer may be used directly below each geomembrane overlap to be seamed to prevent the buildup of moisture between the sheets.
- e. The electric generator used for power supply to the welding machines shall be placed outside the area to be lined or mounted on soft tires such that no damage occurs to the geomembrane. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

### H. Trial Seams

- 1. Trial seams shall be made prior to production seaming by all seamers and by all equipment to be used during production seaming. The trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period and at least once each five hours for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams. The trial seam sample shall be at least 5 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as specified in Section 3.3(D) of this Specification.
- 2. Two adjoining specimens, each 1 inch wide, shall be cut from the trial seam sample by the Geosynthetics Installer. The specimens shall be tested in shear

and peel, respectively, using a field tensiometer, and the specimen shall fail by film tear bond rather than in the seam. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

3. The trial seams shall meet the required strength values shown in Table 02072-2.

## I. Nondestructive Seam Continuity Testing

1. The Geosynthetics Installer shall nondestructively test all field seams over their full length using a vacuum test, air pressure test (for double fusion seams only), or other approved method. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. The installer shall complete any required repairs in accordance with Section 3.3(K) of this Specification. The following procedures shall apply to locations where seams cannot be nondestructively tested:

- a. If the seam is accessible to testing equipment prior to final installation, the seam shall be nondestructively tested prior to final installation.
- b. If the seam cannot be tested prior to final installation, the seaming operations must be observed in their entirety by the Engineer for uniformity and completeness.

## 2. Vacuum Testing

- a. The equipment shall comprise the following:
  - 1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.
  - 2) A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
  - 3) A rubber pressure/vacuum hose with fittings and connections.
  - 4) A bucket and applicator.
  - 5) A soapy solution.
- b. The following procedures shall be followed:
  - 1) Energize the vacuum pump and reduce the tank pressure to approximately 5 pounds per square inch (psi) gauge.
  - 2) Wet a strip of geomembrane seam having an area larger than the vacuum box assembly with the soapy solution.



- 3) Place the box over the wetted area.
  - 4) Close the bleed valve and open the vacuum valve.
  - 5) Ensure that a leak tight seal is created.
  - 6) Examine the geomembrane through the viewing window for the presence of soap bubbles for not less than 10 seconds.
  - 7) If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap, and repeat the process.
  - 8) All areas where soap bubbles appear shall be marked with a marker that will not damage the geomembrane and repaired in accordance with Section 3.3(K) of this Specification.
3. Air Pressure Testing (For Double Fusion Seams Only)
- a. The following procedures are applicable to those processes which produce a double seam with an enclosed space.
  - b. The equipment shall comprise the following:
    - 1) An air pump (manual or motor driven), equipped with a pressure gauge, capable of generating and sustaining a pressure between 25 and 30 psi, mounted on a cushion to protect the geomembrane.
    - 2) A rubber hose with fittings and connections.
    - 3) A sharp hollow needle, or other approved pressure feed device.
  - c. The following procedures shall be followed:
    - 1) Seal both ends of the seam to be tested.
    - 2) Insert needle, or other approved pressure feed device, into the channel created by the fusion weld.
    - 3) Insert a protective cushion between the air pump and the geomembrane.
    - 4) Energize the air pump to a pressure between 25 and 30 psi, close valve, allow two minutes for pressure to stabilize, and sustain the pressure for not less than five minutes.
    - 5) If loss of pressure exceeds 4 psi, or if the pressure does not stabilize, locate faulty area and repair in accordance with Section 3.3(K) of this Specification.

- 6) Cut opposite end to verify continuity of seam, remove needle, or other approved pressure feed device, and seal repair in accordance with Section 3.3(K) of this Specification.

## J. Destructive Testing

1. Destructive seam tests shall be performed on samples collected from selected locations to evaluate seam strength and integrity. Destructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.
2. The destructive seam tests shall meet the required strength values shown in Table 02072-2.
3. Sampling
  - a. Destructive test samples shall be collected at a minimum frequency of one test location per day per seaming crew or seaming machine at least every 500 feet of seam length (not including repairs). Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming. The Engineer will be responsible for choosing the locations. The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples will be taken. The Owner and/or Engineer reserve the right to increase the sampling frequency.
  - b. Samples shall be cut by the Geosynthetics Installer at the locations designated by the Engineer as the seaming progresses in order to obtain laboratory test results before the geomembrane is covered by another material. All holes in the geomembrane resulting from the destructive seam sampling shall be immediately repaired in accordance with the repair procedures described in Section 3.3(K) of this Specification. The continuity of the new seams in the repaired areas shall be tested according to Section 3.3(I) of this Specification.
  - c. Two strips, 1 inch wide and 12 inches long with the seam centered parallel to the width, shall be taken. The strips shall be spaced a clear distance of 42 inches apart. These samples shall be tested in the field in accordance with Section 3.3(J)(3) of this Specification. If these samples pass the field test, a laboratory sample shall be taken. The laboratory sample shall be at least 1 foot wide by 42 inches long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:
    - 1) One 1-foot long portion to the Geosynthetics Installer for field testing.
    - 2) One 1.5-foot long portion to the Engineer for laboratory testing.
    - 3) One 1-foot long portion to the Engineer for archival storage.
4. Field Testing: The two 1-inch wide strips shall be tested in the field using the field by tensiometer for peel and shear respectively. If any field test sample fails

to pass, then the procedures outlined in Section 3.3(K) of this Specification shall be followed.

5. Laboratory Testing: Samples shall be tested in the laboratory in accordance with the methodology of ASTM D6392. Perform peel testing for dual hot wedge fusion welds on the inside and outside tracks.
  - a. Each destructive seam sample shall be tested for the following:
    - 1) Shear strength, expressed in pounds per inch (ppi), when tested in general accordance with ASTM D6392.
    - 2) Peel strength, expressed in ppi, when tested in general accordance with ASTM D6392.
  - b. The testing laboratory shall report the following values, along with the mean and standard deviations where appropriate, for each sample tested in shear:
    - 1) Maximum tension in pounds per square inch.
    - 2) Elongation at break (up to a tested maximum of 100%).
    - 3) The locus of failure.
  - c. The testing laboratory shall report the following values, along with the mean and standard deviations where appropriate, for each sample tested in peel:
    - 1) Maximum tension in pounds per square inch.
    - 2) Seam separation (expressed as percent of original seam area).
    - 3) The locus of failure.
  - d. Retesting of seams, because of failure to meet any or all of the specifications, may be performed at the sole discretion of the Engineer.
6. Destructive Test Failure
  - a. The following procedures shall apply whenever a sample fails a destructive test, whether the test is conducted by the Owner's laboratory, the Geosynthetics Installer's laboratory, or by a field tensiometer. The Geosynthetics Installer shall have two options, as described in b and c below.
  - b. The Geosynthetics Installer can reconstruct the seam (e.g., remove the old seam and reseat) between any two passed test locations.
  - c. The Geosynthetics Installer can trace the welding path to an intermediate location, a minimum of 10 feet from the location of the failed test (in each direction) and take a small sample for an additional field test at each location. If these additional samples pass the tests, then full laboratory

samples shall be taken. If these laboratory samples pass the tests, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases where the length of reconstructed seam exceeds 150 feet, a destructive sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, the Engineer may require additional tests for seams that were formed by the same seamer and/or seaming apparatus or seamed during the same time shift.

## K. Defects and Repairs

1. All seams and non-seam areas of the geomembrane will be examined by the Engineer for evidence of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be swept or washed by the Geosynthetics Installer if surface contamination inhibits examination. The Geosynthetics Installer shall ensure that this examination of the geomembrane precedes any seaming of that section.
2. Each suspect location, both in seam and non-seam areas, shall be nondestructively tested using the methods described Section 3.3(I) of this Specification, as appropriate. Each location which fails nondestructive testing shall be marked by the Engineer and repaired by the Geosynthetics Installer. Work shall not proceed with any materials which will cover repaired locations until laboratory test results with passing values are available.
3. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the Engineer shall identify all excessive geomembrane wrinkles. The Geosynthetics Installer shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested like any other seams.
4. Repair Procedures
  - a. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetics Installer. Several repair procedures are specified below. The final decision as to the appropriate repair procedure shall be agreed upon between the Engineer and the Geosynthetics Installer. The procedures available include:
    - 1) Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
    - 2) Abrading and reseaming, used to repair small sections of extruded seams;
    - 3) Spot seaming, used to repair small tears, pinholes, or other minor, localized flaws;

- 4) Capping, used to repair long lengths of failed seams;
  - 5) Removing bad seam and replacing with a strip of new material seamed into place (used with long lengths of fusion seams).
- b. In addition, the following shall be satisfied:
- 1) Surfaces of the geomembrane to be repaired shall be abraded no more than one hour prior to the repair;
  - 2) All surfaces must be clean and dry at the time of repair;
  - 3) All seaming equipment used in repair procedures must be approved by the Engineer;
  - 4) The repair procedures, materials, and techniques shall be approved in advance for the specific repair by the Engineer and Geosynthetics Installer;
  - 5) Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches; and
  - 6) The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.
5. Each repair shall be numbered and logged and shall be nondestructively tested using the methods described in Section 3.3(l) of this Specification, as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test result is achieved. At the discretion of the Engineer, destructive testing may be required on large caps.

### 3.4 MATERIALS IN CONTACT WITH THE LINER

- A. The Geosynthetics Installer shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation or during the installation of other components of the final cover system or by other construction activities. Installation on rough surfaces shall be performed carefully. If approved by the Engineer, additional loosely placed geotextile sections may be used by the Geosynthetics Installer to protect the geomembrane.
- B. No granular materials shall be placed directly on the geomembrane at any time. A geotextile cushion shall be installed between aggregate and any geomembrane.
- C. Equipment shall not be driven directly on the geomembrane. Unless otherwise specified by the Engineer, all equipment operating on materials overlying the geomembrane shall comply with the following:

Allowable Equipment Ground Pressure (psi)	Thickness of Overlying Compacted Fill (feet)
<5	1.0
<15	1.5
<20	2.0
>20	3.0

- D. In heavily trafficked areas such as access ramps, and in areas trafficked by rubber tire vehicles, the thickness of overlying compacted fill shall be at least 3 feet.
- E. Installation of the geomembrane in sump areas, and connection of the geomembrane to appurtenances shall be made according to these Specifications and as shown on the Construction Drawings. Extreme care shall be taken while seaming around sumps and appurtenances (where applicable), since neither nondestructive nor destructive testing may be feasible in these areas. The Geosynthetics Installer shall ensure that the geomembrane has not been visibly damaged while making connections to sumps and appurtenances. Because of the difficulty of vacuum testing seams in the sump area, fusion seams should be made at all possible locations in the sump.

## 3.5 GEOMEMBRANE ACCEPTANCE

- A. The Geosynthetics Installer shall retain all ownership and responsibility for the geomembrane until accepted by the Engineer.
- B. The geomembrane will not be accepted by the Engineer until all of the following conditions are met:
  - 1. The installation is finished;
  - 2. All documentation of installation is completed including the Engineer's final report;
  - 3. Verification of the adequacy of all field seams and repairs, including associated testing, is complete; and
  - 4. Written certification documents shall be provided by the Geosynthetics Installer. Also, record drawings, certified by the Geosynthetics Installer and signed and sealed by a Professional Surveyor, shall be provided..

## 3.6 PRODUCT PROTECTION

- A. The Contractor shall use all means necessary to protect all prior work and all materials and completed work of other Sections.
- B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Engineer and at no additional cost to the Owner.

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Willow Boulevard/A-Site Landfill Operable Unit 2  
Final Design Specifications**

**Table 02072-1 – LLDPE Textured Geomembrane Factory QC Certification and QA  
Conformance Testing Protocol**

Item	Test Method	Requirement
Thickness	ASTM D5994	40 mil nominal 38 mil (minimum average) 36 mil (lowest individual for 8 out of 10 values) 34 mil (lowest individual for any of the 10 values)
Density	ASTM D1505/ ASTM D 792	0.939 g/ml (maximum)
2% Modulus	D 5323	2400 (maximum)
Break Strength <sup>3</sup>	ASTM D6693 Type IV	60 lb/in (minimum average)
Break Elongation <sup>4</sup>	ASTM D6693	250% (minimum average)
Tear Resistance	ASTM D1004	22 lbs (minimum average)
Puncture Resistance	ASTM D4833	44 lbs (minimum average)
Carbon Black Content	ASTM D1603 <sup>5</sup>	2.0% to 3.0%
Carbon Black Dispersion	ASTM D5596	9 in Categories 1 or 2 and 1 in Category 3
Axi-Symmetric Break Resistance Strain	ASTM D5617	30% (minimum)
Asperity Height <sup>2</sup>	ASTM D7466	10 mil (minimum average)
Oxidative Induction Time (OIT)	ASTM D3895	100 % (Standard OIT, minimum average)
	ASTM D5885	400% (High Pressure OIT, minimum average)
Oven Aging at 85°C	ASTM D5721	35 % (Standard OIT, minimum average, retained after 90 days) or <sup>6</sup>
	ASTM D3895	
	ASTM D5885	60% (High Pressure OIT, minimum average, retained after 90 days)
UV Resistance	ASTM D5885	35% (High Pressure OIT, minimum average, retained after 1600 hours) <sup>7</sup>

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## Notes:

1. Minimum test values based on current manufacturers specifications, and may change based on future manufacturers guaranteed minimum test values.  
  
g/mil = grams per thousandth of an inch  
lbs = pounds  
lb/in = pounds per inch  
mil = thousandth of an inch
2. Of 10 readings, 8 out of 10 must be greater than or equal to 7 mils and the lowest individual reading must be greater than or equal to 5 mils.
3. Machine direction and cross direction average values should be on the basis of 5 test specimens in each direction.
4. Machine direction and cross direction average values should be on the basis of 5 test specimens in each direction. Break elongation is based on a gage length of 2.0 inches at 2.0 inches/minute.
5. Other methods such as ASTM D 4218 (*muffle furnace*) of microwave methods are acceptable if an appropriate correlation to ASTM D 1603 (tube furnace) can be established.
6. The manufacturer has the option to select either one of the OIT methods listed (i.e., Standard OIT or High Pressure OIT).
7. UV resistance testing is not necessary for Standard OIT testing. The condition of the test should be 20 hours UV cycle at 75 °C followed by 4 hours condensation at 60 °C. UV resistance is based on percent retained value regardless of the original High Pressure OIP value.



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Willow Boulevard/A-Site Landfill Operable Unit 2  
Final Design Specifications**

**Table 02072-2 – LLDPE Textured Geomembrane Seam Testing**

Item	Test Method	Frequency	Requirement
Bonded Shear Strength	ASTM D6392	1/500 feet (maximum) <sup>1</sup>	60 lb/in (minimum)
Peel Strength	ASTM D6392	1/500 feet (maximum) <sup>1</sup>	Fusion - 50 lb/in (minimum) Extrusion - 44 lb/in (minimum)

Notes:

1. For fusion welded seams, frequency is based on welding device footage; for extrusion welded seams, frequency is based on operator footage.
2. Minimum test values based on current manufacturers specifications, and may change based on future manufacturers guaranteed minimum test values. List Locus of Break in laboratory test results.

END OF SECTION

## SECTION 02073

### GEOSYNTHETIC DRAINAGE COMPOSITE

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Geosynthetics Installer shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary for the installation of a geosynthetic drainage composite (GDC) as specified in the Project Documents. The Geosynthetics Installer shall be under direct contract to the Contractor.
- B. The Contractor shall be prepared to install the GDC in conjunction with the earthworks and other components of the final cover system.
- C. The Geosynthetics Installer shall install the GDC.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
  - 2. D1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
  - 3. D3786 Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
  - 4. D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
  - 5. D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity
  - 6. D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
  - 7. D4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
  - 8. D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
  - 9. D4716 Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Properties

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- 10. D4751      Standard Test Method for Determining Apparent Opening Size of a Geotextile
- 11. D4833      Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- 12. D5199      Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- 13. D5261      Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- 14. D7005      Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites

## 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractors shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

## 1.4 QUALIFICATIONS

### A. Contractor:

- 1. The Geosynthetics Installer will be contracted directly by the Contractor. The Geosynthetics Installer shall meet the qualification requirements of this Specification.

### B. GDC Manufacturer:

- 1. The GDC Manufacturer shall have at least 3 years of continuous experience in manufacturing GDC and have produced 10,000,000 square feet (minimum) of GDC.
- 2. The GDC Manufacturer shall have sufficient production capacity and qualified personnel to meet the demands (e.g., quantity production and quality control) of this project.

### C. GDC Installer:

- 1. The Geosynthetics Installer of the geomembrane shall be responsible for field handling, storing, deploying, seaming, temporarily restraining (against wind), and other site aspects of the GDC and other components of the final cover system.
- 2. The Geosynthetics Installer shall have at least 5 years of continuous experience in installing GDC and have installed 5,000,000 square feet (minimum) of GDC.
- 3. Personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests.

4. The laboratory used by the Geosynthetics Installer for laboratory testing of destructive seam samples shall have extensive experience with all types of geosynthetics and be accredited members of the Geosynthetics Accreditation Institute – Laboratory Accreditation Program (GAI-LAP).

D. Conformance Testing and Interface Friction/Direct Shear Testing Laboratory

1. An independent laboratory contracted directly by the Owner, shall be used for conformance testing and interface friction/direct shear testing as required by this specification. The Conformance Testing Laboratory shall have extensive experience with all types of geosynthetics and be accredited members of the GAI-LAP.

## 1.5 SUBMITTALS

- A. The following items shall be submitted no later than 30 days prior to the start of GDC installation or 15 days prior to delivery of the first GDC shipment, whichever is earliest.

1. The GDC Manufacturer shall submit the following information in writing to the Owner and the Owner's Representative:
  - a. Corporate background and information.
  - b. Manufacturing Quality Control (MQC) Plan. The MQC Plan shall include installation, handling, storage and repair techniques.
  - c. Manufacturing capabilities, including:
    - 1) Information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
    - 2) Daily production quantity available for this Contract;
    - 3) Manufacturing quality control procedures; and
    - 4) List of material properties, including certified test results, attached to which is a GDC material sample.
  - d. A list of at least 10 completed facilities for which the GDC Manufacturer has manufactured a minimum of 10,000,000 square feet of GDC. The following information shall be provided:
    - 1) Name, location, and purpose of facility, and date of installation;
    - 2) Names of Owner, Project Manager, Engineer, General Contractor, and installer; and
    - 3) Type and surface area of GDC manufactured.
  - e. Results of tests conducted by the GDC Manufacturer to verify the quality of the resin used to manufacture the GDC manufactured for this project.

- f. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the polyethylene resin.
  - g. Copies of quality control certificates issued by the resin supplier.
  - h. Certification that no reclaimed polymer is added to the resin during the manufacture of the GDC to be used for this project.
  - i. Quality control certificates providing the results of the quality control tests outlined in Section 2.3(A) of this Specification.
    - 1) The quality control certificates shall include:
      - a) Roll numbers and identification;
      - b) Sampling procedures; and
      - c) Results of quality control tests, including descriptions of the test methods used.
2. The Geosynthetics Installer shall submit the following information in writing to the Owner and the Owner's Representative:
- a. Corporate background and information.
  - b. Copy of installer's letter of approval or license by the GDC Manufacturer and/or fabricator.
  - c. Construction Quality Control (CQC) Plan.
  - d. Installation capabilities, including:
    - 1) Information on equipment and personnel;
    - 2) Average daily production anticipated for this project; and
    - 3) Quality control procedures.
  - e. A list of at least 10 completed facilities, for which the installer has installed a minimum of 5,000,000 square feet of GDC. The following information shall be provided for each facility:
    - 1) The name and purpose of the facility, its location, and dates of installation;
    - 2) The names of the Owner, Project Manager, Engineer, General Contractor, GDC Manufacturer, and the name of a contact at the facility who can discuss the project;
    - 3) Name and qualifications of the installer's supervisor(s);

- 4) Thickness and surface area of installed GDC; and
    - 5) Duration of installation.
  - f. Installation schedule
  - g. The name and qualifications of the proposed laboratory that will be responsible for laboratory testing of destructive seam samples.
- 3. The Contractor shall submit the following information in writing to the Owner and the Owner's Representative:
  - a. Written certification that the field-delivered GDC has not been damaged due to improper transportation, handling, or storage.
  - b. Written certification that the surface on which the GDC is to be installed is acceptable to both the Engineer and the Contractor. The certification is subject to the review and approval or rejection by the Owner.
- B. During installation, the Geosynthetics Installer shall submit the following information to the Owner and the Owner's Representative:
  - 1. Daily field installation reports. The reports shall include the following information:
    - a. Surface area and location of GDC placed;
    - b. Identifiers of rolls and fabricated blankets;
    - c. Quality control tests of materials used during the day;
    - d. Total amount and locations of seams completed;
    - e. Seaming procedures used;
    - f. Changes in layout drawings;
    - g. Location and type of repairs; and
    - h. Observations of seams around appurtenances and connection to appurtenances.
- C. Upon completion of the installation, the Geosynthetics Installer shall be responsible for the timely submission of the following to the Owner and the Owner's Representative:
  - 1. As-built panel layout diagram.
  - 2. Warranty from GDC Manufacturer/Installer as specified in Section 1.6 of this Specification.

## 1.6 WARRANTY

The GDC Manufacturer and Geosynthetics Installer shall furnish a standard written warranty against defects in material and workmanship to the Owner and the Owner's Representative. Warranty conditions concerning limits of liability will be evaluated and accepted by the Owner.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

#### A. Geosynthetic Drainage Composite

GSE Lining Technology, LLC  
19103 Gundle Road  
Houston, TX 77073  
800.435.2008

TENAX Corporation  
4800 East Monument Street  
Baltimore, MD 21205  
800.356.8495

- B. An alternate GDC Manufacturer may be considered. The Contractor shall submit the alternate material to the Engineer for review.

### 2.2 GEOSYNTHETIC DRAINAGE COMPOSITE MATERIAL

The GDC shall be composed of a high density polyethylene (HDPE) drainage net with a nonwoven, needle punched geotextile bonded to each side of the drainage net. The geotextile shall not be glued or bonded to the geonet in any manner other than heat bonding. Along edges, 6 inches of the geotextile shall not be heat bonded to the geonet to allow connection in the field.

#### A. GDC Material Properties

1. The GDC Manufacturer shall furnish GDC having material properties that comply with the required property values shown in Table 02073-1. The Manufacturer shall provide test results for these procedures, as well as a certification that the materials meet or exceed the specified values.
2. In addition to the property values listed in Table 02073-1, the GDC shall do the following.
  - a. Retain its structure during handling, placement, and long-term service.
  - b. Be capable of withstanding ultraviolet exposure for at least one year.

#### B. Fabrication

1. The GDC shall be manufactured with quality control procedures that meet generally accepted industry standards.
2. Labels on each GDC roll shall identify the following information:
  - a. Name of GDC Manufacturer;
  - b. Product Identification;

- c. Roll number and dimensions; and
  - d. Lot/Batch number.
3. The GDC shall be kept clean and free from dirt, dist, mud, and any other debris.

## 2.3 GEOSYNTHETIC DRAINAGE COMPOSITE TESTING REQUIREMENTS

### A. GDC Manufacturer's Quality Control Testing

1. The GDC Manufacturer shall sample and test the GDC to demonstrate that the material complies with the requirements of this Specification. The GDC Manufacturer shall certify in writing that the GDC meeting this Specification, and shall be held liable for any non-compliance.
2. Sampling shall, in general, be performed on sacrificial portions of the GDC material such that repair is not required. The GDC Manufacturer shall sample and test the geonet component of the GDC in accordance with the MQC Plan, to demonstrate that its properties conform to the values specified in Table 02073-1. Geotextile components shall be sampled and tested in accordance with the MQC Plan. At a minimum, the following manufacturing quality control tests shall be performed:

	<u>Test</u>	<u>Procedure</u>
Geonet Component	Polymer Composition	NA
	Density	ASTM D792
	Thickness	ASTM D5199
	Carbon black	ASTM D4218
	Melt Index	ASTM D1238

	<u>Test</u>	<u>Procedure</u>
Geotextile Component	Polymer composition	NA
	Mass per unit area	ASTM D5261
	Apparent opening size	ASTM D4751
	Permittivity	ASTM D4491
	Grab strength	ASTM D4632
	Tear strength	ASTM D4533
	Puncture Resistance	ASTM D4833
	Mullen Burst	ASTM D3786

GDC Component	Thickness	ASTM D5199
	Ply Adhesion	ASTM D7005

3. The GDC Manufacturer shall certify that the transmissivity test has been performed on a sample of GDC identical to the product that will be delivered to the site. The GDC Manufacturer shall provide test results to the Engineer demonstrating that the GDC Manufacturer performed the tests and that acceptable results were obtained.



4. The Manufacturer shall comply with the certification and submittal requirements specified in the Project Documents.
5. If a GDC sample fails to meet the quality control requirements of this Specification, the Contractor will require that the GDC Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.
6. Additional sample testing may be performed, at the Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.
7. The Contractor shall submit the GDC Manufacturer's test results to the Engineer for review prior to shipping any rolls of GDC.
8. Any GDC sample that does not comply with the requirements of this Specification will result in rejection of the roll from which the sample was obtained.
9. The Contractor shall replace any rejected rolls of GDC at no additional cost to the Owner.

## B. Conformance Testing

1. Prior to installation, samples of delivered GDC shall be taken and shipped to a third party testing laboratory (i.e. the Owner's Conformance Testing Laboratory) for conformance testing independent of the manufacturer's testing. Unless otherwise specified, the samples shall be taken at a minimum frequency of one sample per 100,000 square feet with a minimum of one sample per lot (regardless of the dates of manufacturing or delivery dates), unless noted otherwise.
2. Sampling shall, in general, be performed on sacrificial portions of the material, such that repair of the material is not required.
3. Conformance testing shall be the responsibility of the Owner.
4. The Contractor shall, at no additional cost to the Owner, provide whatever reasonable assistance the Engineer may require in obtaining the samples for conformance testing.
5. At a minimum, the following conformance tests shall be performed on the GDC samples:

<u>Test</u>	<u>Procedure</u>
Ply Adhesion	ASTM D7005
Transmissivity	ASTM D4716

6. Prior to installation, the Engineer shall review the conformance test results against the material properties required by Table 02073-2. Non-conforming material will be rejected and bracketed from subsequent rolls from the same product batch.
7. The Engineer may increase the frequency of GDC sampling in the event that test results do not comply with requirements of Section 2.2 of this Specification. This additional testing shall be performed at the expense of the Contractor.
8. Any GDC not certified in accordance with Section 1.5 of this Specification, or that conformance testing indicates the GDC does not comply with Section 2.2 of this Specification, will be rejected by the Engineer. The Contractor shall replace the rejected material with new material, at no additional cost to the Owner.

## 2.4 TRANSPORTATION

Transportation of the GDC material shall be the responsibility of the GDC Manufacturer. The GDC Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation to the site.

## 2.5 HANDLING AND STORAGE

- A. Handling, storage, and care of the GDC material prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the final cover system.
- B. The Contractor shall be responsible for storage of the GDC material at the site. The GDC material shall be stored off the ground and out of direct sunlight, and shall be protected from mud, dirt, and dust. The GDC shall be stored in accordance with any additional requirements of the GDC Manufacturer.

## PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

- A. The areas designated for placement of GDC shall be free from any deleterious material.
- B. If the GDC is not clean before installation, it shall be washed by the Geosynthetics Installer until accepted by the Engineer.
- C. Prior to installation of any GDC, the Engineer and the Contractor must both concur that the underlying geomembrane is acceptable. This will necessitate reviewing of all quality assurance/quality control (QA/QC) testing of the geomembrane by the Engineer and the Contractor. The Contractor shall submit a written verification that

both the Engineer and the Contractor agree that the underlying geomembrane is acceptable (refer to Section 1.5(A)(3)(b) of this Specification).

## 3.2 INSTALLATION

- A. GDC shall be installed at the locations shown on the Construction Drawings and in accordance with the GDC Manufacturer's instructions.
- B. The GDC shall be unrolled downslope, keeping the net in slight tension to minimize wrinkles and folds.
- C. If a tri-planar material is used, it must be installed in the appropriate flow direction.
- D. In the presence of wind, the GDC shall be secured using sandbags until overlying final cover soils are installed.
- E. Seams and Overlaps
  - 1. The components of the GDC (i.e., geotextile-geonet-geotextile) are not to be bonded together at the ends and edges of the rolls. The unbonded width of the geonet (to the geotextile) shall be a minimum of 4 inches on both edges of the rolls. Each component will be secured or seamed to the like component at overlaps.
  - 2. Geonet Components
    - a. The geonet components shall be overlapped by at least 4 inches. These overlaps shall be secured by tying.
    - b. Tying devices shall be white or yellow plastic fasteners or polymer braid. Metallic devices shall not be used.
    - c. The geonet overlap shall be secured with ties every 5 feet along the slope, and every 6 inches in the anchor trench and on end-to-end seams.
  - 3. Geotextile Components
    - a. The bottom layers of geotextile shall be overlapped a minimum of 4 inches prior to seaming. The top layers of geotextiles shall be continuously sewn (i.e., spot sewing or thermal bonding is not allowed).
    - b. Polymeric thread with chemical resistance properties equal to or exceeding those of the geotextile component shall be used for all sewing.

## 3.3 REPAIR

- A. Any holes or tears in the GDC material shall be repaired by placing a patch extending beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet on the slope. The patch shall be secured every 6 inches with approved tying devices. The top geotextile component of the patch shall be heat

sealed to the top geotextile of the GDC needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the entire damaged GDC panel shall be removed and replaced.

## 3.4 MATERIALS IN CONTACT WITH THE GEOSYNTHETIC DRAINAGE COMPOSITE

- A. The Contractor shall take all necessary precautions to ensure that the GDC is not damaged during the installation of the all final cover soil materials.
- B. Equipment shall not be driven directly on the GDC at any time. Unless otherwise specified by the Engineer, all equipment operating on soil material overlying the GDC shall comply with the following:

Allowable Equipment Ground Pressure (pounds per square inch [psi])	Thickness of Overlying Compacted Fill (feet)
<5	1.0
<10	1.5
<20	2.0
>20	3.0

- C. In areas of heavy traffic, such as access ramps and areas traveled by vehicles with rubber tires, the thickness of overlying compacted fill shall be at least 3 feet.

## 3.5 PRODUCT PROTECTION

- A. The Contractor shall use all means necessary to protect all prior work and all materials and completed work of other Sections.
- B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

**Georgia-Pacific LLC  
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site  
Willow Boulevard/A-Site Landfill Operable Unit 2  
Final Design Specifications**

**Table 02073-1 - Geosynthetic Drainage Composite Components Factory Quality Control  
Certification and Quality Assurance Conformance Testing Protocol**

Item	Test Method	Requirement
Polymer Composition (Geonet Component)	NA	95% Polyethylene by Weight (minimum)
Density (Geonet Component)	ASTM D792	0.94 g/cm <sup>3</sup> (minimum)
Melt Index (Geonet Component)	ASTM D1238	1.0 (maximum)
Carbon Black Content (Geonet Component)	ASTM D4218	2.0% to 3.0%
Tear Strength (Geotextile Component)	ASTM D4533	60 lb/in
Mass Per Unit Area (Geotextile Component)	ASTM D5261	5.7 oz/sq yd (minimum)
Apparent Opening Size (AOS) (Filter Requirement)	ASTM D4751	70 US Sieve
Permittivity (Filter Requirement)	ASTM D4491	1.1 sec <sup>-1</sup> (minimum)
Grab Tensile (Geotextile)	ASTM D4632	160 lbs (minimum)
Puncture Resistance (Geotextile)	ASTM D4833	85 lbs (minimum)

Notes:

1. Minimum test values based on current manufacturer's specifications, and may change based on future manufacturer's guaranteed minimum test values.
2. The minimum average roll value (MARV) is defined as the mean value minus two times the standard deviation. A MARV value yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported. Once the MARV values are established and published, the manufacturer, through its standard manufacturing quality control program, continues to monitor, quantify, and document the properties of the geotextile to assure that the material stays within the published values. This is done by testing a specific frequency determined by the variability of geotextile industry standard and is endorsed by Dr. Robert M. Koerner of the Geosynthetics Research Institute (GRI) (Koerner, 1994). Both American Association of State Highway and Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) recommend the use of MARV in geotextile production specifications (AASHTO, 1994), (FHWA, 1995).

g/cm<sup>3</sup> = grams per cubic centimeter  
oz/sq yd = ounces per square yard

lb/in = pounds per inch

## FACTORY QC REQUIREMENTS

Prior to the installation of any GDC, the Manufacturer shall provide the following information.

1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the geotextile and geonet used to fabricate the GDC.
2. Copies of dated quality control certificates issued by the geotextile and geonet supplier. These certificates shall contain the results of the quality control tests performed on the GDC components outlined in the project specifications.
3. A specification for the GDC which includes all properties published by the Manufacturer measured using the appropriate test methods.
4. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
5. All testing and evaluation of results must be performed in accordance with this specification and project Construction Quality Assurance Plan.

The Manufacturer shall identify all rolls of GDC with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

**Georgia-Pacific LLC  
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Willow Boulevard/A-Site Landfill Operable Unit 2  
Final Design Specifications**

**Table 02073-2 - Geosynthetic Drainage Composite Factory QC Certification and QA  
Conformance Testing Protocol**

Item	Test Method	Requirement
Ply Adhesion (Composite)	ASTM D7005	1 lbs/in (minimum)
Transmissivity (Composite)	ASTM D4716	$1.66 \times 10^{-3} \text{ m}^2/\text{sec}$ (minimum) <sup>2</sup>

Notes: 1. Minimum test values based on current manufacturers specifications, and may change based on future manufacturers guaranteed minimum test values.

2. Composite Transmissivity Test Conditions.

- Gradient = 0.1
- Seating Time = 100 hours
- Normal Pressure = 2,615 pounds per square foot (psf)
- Confining Materials: Substrate = 40 mil linear low-density polyethylene (LLDPE) geomembrane, Superstrate = 6 inches of representative cover soil

$\text{m}^2/\text{sec}$  = square meters per second

#### **SAMPLING PROCEDURES**

Upon delivery of the rolls of the GDC, the Engineer shall ensure that conformance test samples are obtained for the GDC. The rolls to be sampled shall be selected by the Engineer. Unless otherwise specified, samples shall be 3 feet (1 meter) long by the roll width. The Engineer shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Engineer based on a review of all roll information, including quality control documentation and manufacturing records.

All conformance test results shall be reviewed and accepted or rejected by the Engineer prior to the deployment of the GDC. The Engineer shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The Engineer shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

#### **TEST RESULTS**

All testing and evaluation of results must be performed in accordance with this specification and project Construction Quality Assurance Plan.

END OF SECTION

## SECTION 02076

### GEOTEXTILE

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of geotextile as specified in the Project Documents.
- B. The Contractor shall install geotextile in conjunction with the earthwork and components of the final cover system.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. D3786 Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
  - 2. D4355 Standard Test Method for Deterioration of Geotextiles by exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus
  - 3. D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity
  - 4. D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
  - 5. D4632 Standard Test Method for Grab Break Load and Elongation of Geotextiles
  - 6. D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
  - 7. D4833 Standard Test Method for Index Puncture Strength of Geotextiles, Geomembranes, and Related Products
  - 8. D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles
  - 9. D6241 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe



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## B. Geosynthetic Research Institute (GRI):

1. GT 13(a) Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate

## 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

## 1.4 QUALIFICATIONS

### A. Geotextile Manufacturer

1. The Geotextile Manufacturer shall be responsible for the production and delivery of geotextile rolls and shall be a well-established firm with more than 2 years experience in the manufacture of geotextile filters and cushions. The Geotextile Manufacturer shall submit a statement to the Engineer listing:
  - a. Certified minimum average roll property values of the geotextiles and the tests used to determine those properties.
  - b. Production capacity available and projected delivery dates for this project.

## 1.5 SUBMITTALS

- A. The Geotextile Manufacturer shall submit the following documentation on geotextile production prior to the shipment of the geotextile rolls to the Owner and the Owner's Representative.
1. Data for geotextiles including, at a minimum, physical properties, packaging, and installation techniques.
  2. Manufacturing Quality Control (MQC) Plan.
  3. Manufacturing quality control certificates for each batch of resin and each shift's production.
    - a. The quality control certificate shall include:
      - 1) Origin of the resin;
      - 2) Manufacturer of the resin;
      - 3) Roll numbers and identification;
      - 4) Sampling procedures; and
      - 5) Results of quality control tests, including a description of the test methods used.

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- b. The certificates shall be signed by responsible parties employed by the manufacturer (such as the production manager).
- 4. Manufacturing quality control test results. The results shall include sampling frequencies and test methods used.
  - a. The Geotextile Manufacturer quality control tests to be performed are outlined in Section 2.2 of this Specification.
- 5. Standard warranty as specified in Section 1.6 of this Specification.

## 1.6 WARRANTY

- A. The Geotextile Manufacturer shall furnish a standard written warranty against defects in material and workmanship to the Owner and the Owner's Representative. Warranty conditions concerning limits of liability will be evaluated and must be acceptable to the Owner.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Geotextile

SKAPS Industries  
335 Athena Drive  
Athens, GA 30601  
1.706.354.3700

US Fabrics Inc  
3904 Virginia Avenue  
Cincinnati, OH 45227  
877.765.1597

- B. An alternate Geotextile Manufacturer may be considered. The Contractor shall submit the alternate material to the Engineer for review.

### 2.2 GEOTEXTILE PROPERTIES

- A. Unless otherwise noted in the Project Documents, the Geotextile Manufacturer shall furnish materials whose "Minimum Average Roll Values," as defined by the Federal Highway Administration (FHWA), meet or exceed the criteria specified in Tables 02076-1 (for non-woven geotextile) or 02076-2 (for woven geotextile). The Geotextile Manufacturer shall provide test results for these procedures, as well as a certification that the material properties meet or exceed the specified values. The geotextiles provided by the Geotextile Manufacturer shall be stock products. The Geotextile Manufacturer shall not furnish products specifically manufactured to meet the specifications of this project unless authorized by the Owner.
- B. The nonwoven geotextile shall be manufactured from continuous filaments or staple fibers. Products shall be either needle punched or heat-bonded, as required in Tables 02076-1.

# ARCADIS

- C. The woven geotextile shall be manufactured from polypropylene slit film yarns.
- D. The Geotextile Manufacturer shall submit documentation that the non-woven and woven geotextiles meet the property values listed in Tables 02076-1 and 02076-2, and that the geotextiles will:
  - 1. Retain their structure during handling, placement, and long-term service.
  - 2. Be capable of withstanding direct exposure to sunlight for a minimum of 30 days with no measurable deterioration.

## 2.3 GEOTEXTILE TESTING REQUIREMENTS

### A. Geotextile Manufacturer's Quality Control Testing

- 1. The Geotextile Manufacturer shall sample and test the non-woven and woven geotextiles in accordance the MQC Plan to demonstrate that its properties conform to the values specified in Tables 02076-1 and 02076-2.
  - a. Samples shall be taken across the entire width of the roll.
  - b. At a minimum, the following manufacturing quality control tests shall be performed for both non-woven and woven geotextiles:

<u>Test</u>	<u>Procedure</u>
Mass Per Unit Area	ASTM D5261
Grab Tensile	ASTM D4632
Trapezoidal Tear	ASTM D4533
Puncture Resistance	ASTM D6241

- 2. Any geotextile not certified in accordance with Section 1.5 of this Specification or failing to comply with the conformance testing requirements of Section 2.2 of this Specification will be rejected by the Engineer. The Geotextile Manufacturer shall replace the rejected material with new material at no additional cost to the Owner.

## 2.4 PACKING AND LABELING

- A. Geotextiles shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.
- B. Geotextile rolls shall be marked or tagged with the following information:
  - 1. Manufacturer's name;
  - 2. Product identification;
  - 3. Lot number;
  - 4. Roll number; and
  - 5. Roll dimensions

## 2.5 TRANSPORTATION

- A. Transportation of the geotextiles is the responsibility of the Geotextile Manufacturer. The Geotextile Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation to the site.
- B. Geotextile material shall be delivered to the site at least 14 days before the planned date of deployment to allow the Engineer adequate time to sample geotextile and perform conformance testing.

## 2.6 HANDLING AND STORAGE

- A. Handling, unloading, storage, and care of the geotextiles prior to, during, and following installation are the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the Contractor's work by the Owner.
- B. The geotextile shall be protected from moisture, direct exposure to sunlight, puncture, or other damaging or deleterious conditions. The geotextile shall be protected from mud, dirt and dust. The geotextile shall be stored in accordance with any additional requirements of the Geotextile Manufacturer.

## PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

- A. The areas designated for geotextile placement shall be free from any deleterious material.
- B. If the geotextile is not clean before installation, it shall be washed by the Geosynthetics Installer until accepted by the Engineer.

### 3.2 INSTALLATION

- A. Geotextile shall be installed at the locations specified in the Project Documents and in accordance with the Geotextile Manufacturer's instructions.
- B. Precautions shall be taken to prevent damage to underlying layers during placement of the geotextile.
- C. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the Owner, based on a formal demonstration from the Geotextile Manufacturer that the geotextile is stabilized against ultra violet (U.V.) degradation for a period in excess of 30 days. Any material not accepted under this paragraph shall be replaced by the responsible party at no cost to the Owner.
- D. If white colored geotextile is used, precautions shall be taken against "snowblindness" of personnel.

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- E. Care shall be taken not to entrap stones, excessive dust, or moisture in the geotextile during placement.
- F. Temporary loads and/or anchors (e.g., sand bags, tires) not likely to damage the geotextile may be placed on the geotextile to prevent uplift by wind (in high winds, continuous loading is recommended along panel edges to minimize the risk of wind flow under the panels).
- G. Surfaces to be covered with geotextile shall be examined before deployment by the Contractor and shall examine the deployed geotextile surface after installation to ensure that no potentially harmful foreign objects are present either above or below the geotextile. Foreign objects shall be removed and damaged geotextile shall be replaced at no additional cost to Owner.
- H. SEAMS AND OVERLAPS
  - 1. On slopes steeper than 5 horizontal to 1 vertical, all geotextiles placed on smooth geomembranes shall be continuously sewn (i.e., spot sewing is not allowed) or thermally bonded. Geotextiles shall be overlapped a minimum 3 inches (150 millimeters [mm]) prior to seaming. No horizontal seams shall be allowed on slopes steeper than 10 horizontal to 1 vertical (i.e., seams shall be along, not across, the slopes).
  - 2. On slopes flatter than 5 horizontal to 1 vertical, or on slopes steeper than 10 horizontal to 1 vertical where geotextiles are placed on textured geomembrane, geotextiles can be either sewn as indicated above, or overlapped a minimum of 1.5 feet (0.45 meter) and thermally bonded. However, sewing will be required if the Contractor or Geosynthetic Installer cannot maintain the overlap during placement of cover soil.
  - 3. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile, shall be used for all sewing. The seam type shall be Federal Standard Type (No. 751.a) SSN-1. The seams shall be sewn using stitch Type 401.

## 3.3 REPAIR

- A. Any holes or tears in the geotextile shall be repaired as follows:
  - 1. On slopes steeper than 5 horizontal to 1 vertical, a patch made from the same geotextile shall be double seamed into place with each seam 0.5 inches (12 mm) apart and no closer than 1 inch (25 mm) from any edge. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced with new material.
  - 2. On slopes flatter than 5 horizontal to 1 vertical, a patch made from the same geotextile shall be continuously sewn in place with a minimum of 1.5 feet (600 mm) overlap in all directions.
- B. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

# ARCADIS

## 3.4 PLACEMENT OF OVERLYING SOIL MATERIALS

- A. The Contractor shall place all soil materials on top of a geotextile in a manner such:
1. The geotextile and underlying materials are not damaged;
  2. Minimum slippage occurs between the geotextile filter and underlying layers during placement; and
  3. Excess stresses are not induced in the geotextile.
- B. Equipment shall not be driven directly on the geotextile. Unless otherwise specified by the Design Engineer, all equipment operating on soil material overlying the geotextile shall comply with the following requirements:

Allowable Equipment Ground Pressure (pounds per square inch [psi])	Thickness of Overlying Compacted Fill (feet)
<5	1.0
<10	1.5
<20	2.0
>20	3.0

## 3.5 PRODUCT PROTECTION

- A. The Contractor shall use all means necessary to protect all prior work and materials and completed work of other Specifications.
- B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Engineer and at no additional cost to the Owner.

**Georgia-Pacific LLC  
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site  
Willow Boulevard/A-Site Landfill Operable Unit 2  
Final Design Specifications**

**Table 02076-1 – Non-Woven Geotextile Factory QC Certification and QA Conformance  
Testing Protocol**

Item	Test Method	Requirement
Polymer Composition	NA	95% Polypropylene or Polyester (minimum)
Construction	NA	Needle punched
Apparent Opening Size (AOS)	ASTM D4751	0.25 mm (maximum)
Permittivity	ASTM D4491	0.2 sec <sup>-1</sup> (minimum)
Grab Tensile	ASTM D4632	158 lbs (minimum)
Grab Elongation	ASTM D4632	50% (minimum)
Trapezoidal Tear	ASTM D4533	56 lbs (minimum)
Puncture Resistance	ASTM D4833	56 lbs (minimum)
Burst Strength	ASTM D3786	189 lbs/in <sup>2</sup> (minimum)
U.V. Resistance	ASTM D4355	50% Retained at 500 hours.

**Notes:**

Minimum test values based on current manufacturers specifications, and may change based on future manufacturers guaranteed minimum test values.

lbs = pounds

lbs/in<sup>2</sup> = pounds per square inch

mm = millimeter

NA = not applicable

Sec<sup>-1</sup> = inverse secant

# ARCADIS

**Table 02076-2 –Woven Geotextile Factory QC Certification and QA Conformance Testing Protocol**

Item	Test Method	Requirement
Polymer Composition	NA	95% Polypropylene or Polyester (minimum)
Grab Tensile	ASTM D4632	248 lbs (minimum)
Trapezoidal Tear	ASTM D4533	90 lbs (minimum)
Puncture Resistance	ASTM D6241	500 lbs (minimum)
U.V. Resistance	ASTM D4355	50% Retained at 500 hours.

**Note:**

Minimum test values based on current manufacturers specifications, and may change based on future manufacturers guaranteed minimum test values.

END OF SECTION



## SECTION 02131

### DECONTAMINATION AND WIPE SAMPLING OF EQUIPMENT

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. All reusable equipment and materials used on-site by the Contractor must be decontaminated prior to their relocation within the work area, prior to handling clean materials, and before the demobilization/departure from the work area.
- B. Prior to departure from the site, each piece of equipment will be inspected and decontaminated depending on its use while on Site. Without exception, all haul vehicles used for importing materials (soil, rock, geotextiles) will be decontaminated using dry methods if possible and wet methods (wheel wash, pressure washer) to remove adhered soil and other visible materials from tires, undercarriage, and sides upon departing site. Contractor will not allow soil, mud or other visible debris to leave the project site or accumulate on local roads.

##### 1.2 REFERENCES

- A. Part 115 Solid Waste Management of the Natural Resources and Environmental Protection Act (NREPA)
- B. 40 Code of Federal Regulations (CFR) 761.79(c)(2)(i) or (ii)

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.4 SUBMITTALS

- A. The Contractor shall submit to the Owner and the Owner's Representative proposed equipment decontamination procedures, including the proposed design and location of the equipment decontamination area.

#### PART 2 PRODUCTS

##### 2.1 MATERIAL REMOVAL

- A. Materials to be used to decontaminate equipment that comes into contact with landfill materials may include, but not be limited to:
  - 1. Simple Green, Kerosene, Spray Bottle(s), Rinse Water, Scrub Brush/Scrub Pad(s), Clean Absorbent Pads, Towels, and Polyethylene Sheeting

## PART 3 EXECUTION

### 3.1 GENERAL

- A. At a minimum, the following procedures shall be executed by the Contractor:
1. For equipment and materials that are being transferred from the work area subject to excavation and grading activities, decontamination must be performed. Materials removed from equipment during decontamination procedures shall be collected and contained on-site. This material will be disposed of with residual materials generated during other site excavation activities prior to installation of the cover system. Any material generated after installation of the cover system must be disposed off-site to a licensed commercial landfill.
  2. The extent and method of decontamination will be at the discretion of the Contractor; however, each piece of equipment or material must be inspected by the Contractor prior to its departure from the work area. The Contractor may be required to perform wipe sampling of the Contractor's equipment used in direct contact with impacted materials, as part of the pre-departure inspection. For the purposes of preparing the bid estimate, the Contractor should assume that it will be required to perform wipe sampling consisting of two wipe samples for each piece of equipment upon arrival, and a total of six wipe samples per piece of equipment to demonstrate that equipment surfaces that contacted target materials exhibit concentrations less than the original results. If wipe sampling indicates concentrations above the original results, the Contractor must re-clean the equipment or materials until wipe sampling indicates concentrations below the original results. Re-cleaning and re-sampling will be at no additional expense to the Owner. Further, no additional costs will be incurred by the Owner while the Contractor awaits sample results.
  3. All material used in equipment washing, including, but not necessarily limited to, detergent solution, rinsate, rinse water, towels, disposable equipment and polyethylene sheeting will be collected and managed consistent with Section 3.1(A)(1) of this Specification. Use of solvent (e.g., hexane) or acid solutions will not be allowed without prior approval from the Engineer.
  4. Wash water, solids, and other materials generated during equipment decontamination shall not contact native materials and existing facilities, and must be collected by the Contractor and treated on-site prior to discharge to the Kalamazoo River in accordance with the Project Documents.
  5. Personnel engaged in decontamination activities shall utilize Personal Protective Equipment (PPE) as appropriate and in accordance with the Contractor's Health and Safety Plan (HASP).
  6. Following Substantial Completion of the Project by the Contractor, the Contractor shall dismantle/demobilize the decontamination area and dispose of to a licensed commercial landfill in accordance with the Project Documents.

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- B. Wipe sample processing (i.e. packaging, shipping to laboratories, and sample analysis) will be the responsibility of the Contractor.
- C. Access roads around the site must be cleaned at least once per day, but more frequently as needed to remove project-related debris.

END OF SECTION

## SECTION 02207

### RESTORATION OF SURFACES

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and equipment necessary for restoration activities as specified in the Project Documents.
- B. The Contractor shall restore and maintain all surfaces disturbed, damaged, or destroyed while performing the work under or as a result of the operations of the Contract as specified herein or as requested by the Engineer.
- C. The quality of materials and the performance of work used in the restoration shall produce a surface or feature equal to or better than the condition of each before the work began, as approved by the Engineer.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.3 SUBMITTALS

- A. The Contractor shall submit a schedule of restoration operations to the Owner and the Owner's Representative for review.

##### 1.4 SCHEDULE OF RESTORATION

- A. After an accepted schedule has been agreed upon, it shall be adhered to unless otherwise revised and approved by the Engineer.
- B. The replacement of surfaces at any time, as scheduled or as requested by the Engineer, shall not relieve the Contractor of responsibility to repair damages by settlement or other failures.

#### PART 2 PRODUCTS

SPECIFIED ELSEWHERE

#### PART 3 EXECUTION

##### 3.1 STONE OR GRAVEL PAVEMENT

- A. All pavement and other areas surfaced with stone or gravel shall be replaced with material to match the existing surface unless otherwise specified on the Construction Drawings.
  - 1. The depth of the gravel shall be at least equal to the existing.
  - 2. After compaction, the surface shall conform to the slope and grade of the area being replaced.

### 3.2 LAWNS AND IMPROVED AREAS

- A. The area to receive vegetative soil shall be graded to a depth of not less than 6 inches or as otherwise specified in the Project Documents or requested by the Engineer, below the proposed finish surface.
  - 1. If the depth of existing vegetative soil prior to construction was greater than 6 inches, vegetative soil shall be replaced to that depth.
- B. The furnishing and placing of vegetative soil, seed and mulch shall meet the requirements of these Specifications.
- C. When required to obtain germination, the seeded areas shall be watered in such a manner as to prevent washing out of the seed.
- D. Any washout or damage that occurs shall be regraded and reseeded until a good sod is established.
- E. The Contractor shall maintain the newly seeded areas in good condition, including regrading, reseeding, watering, and mowing.

### 3.3 OTHER TYPES OF RESTORATION

- A. Trees, shrubs, and landscape items inadvertently damaged or destroyed as a result of the construction operations shall be replaced in like species and size.
  - 1. All planting and care thereof shall meet the standards of the American Association of Nurserymen.
- B. Drainage structures, including culverts, manholes, catch basins, and piping, that are destroyed or removed as a result of the construction operations shall be replaced in like size and material, and shall be replaced at the original location and grade unless otherwise shown on the Construction Drawings. When there is minor damage to a culvert and with the consent of the Engineer, a repair may be undertaken if satisfactory results can be obtained.
- C. Fences destroyed or removed as a result of the construction operations shall be replaced in like size and material, and shall be replaced at the original location unless otherwise noted.

# ARCADIS

## 3.4 MAINTENANCE

- A. The finished products of restoration shall be maintained in an acceptable condition for and during a period of one year following the date of Substantial Completion or other such date as set forth elsewhere in the Project Documents.

END OF SECTION

## SECTION 02232

### CLEARING AND GRUBBING

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals necessary to complete the work specified in the Project Documents. The work shall include, but may not be limited to:
  - 1. Clearing and grubbing the work area of trees, brush, pieces of rock up to 2 cubic yards in volume, large boulders and incidental debris within the limits required for excavation/restoration earthwork and final cover construction;
  - 2. Chipping the cleared trees and brush;
  - 3. Stripping vegetative soil;
  - 4. Transporting stripped soil to stockpiles at locations shown on the Construction Drawings and as directed by the Owner; and
  - 5. Stabilizing of soil stockpiles.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

#### PART 2 MATERIALS

##### 2.1 MATERIALS

- A. Materials to be cleared include trees, shrubs, and any debris or other foreign matter that is neither vegetative soil nor suitable for inclusion in the subgrade foundation, as determined by the Engineer.
- B. Vegetative soil shall be the surficial material consisting of organic soils that typically occurs at the site to a depth of approximately 1 foot beneath ground surface.

#### PART 3 EXECUTION

##### 3.1 CLEARING AND GRUBBING

- A. Clearing and grubbing shall be performed within the limit of construction shown on the Construction Drawings and approved by the Owner. Appropriate erosion and sedimentation controls shall be in place before the start of clearing, as described in

# ARCADIS

Section 01571 (Erosion and Sediment Control) and as shown on the Construction Drawings.

- B. If weather conditions are unsuitable for clearing and grubbing, the Contractor shall cease operations until site conditions are suitable to resume operations.
- C. The Contractor shall clear all areas required for access to the site and for execution of the project work. Clearing shall consist of cutting all woody vegetation to grade and removing and cutting of trees. The Contractor shall also, to the satisfaction of the Engineer, chip all non-marketable timber and other vegetation designated for removal, including downed timber, brush, and rubbish occurring in the area to be cleared.
- D. Any timber that is greater than 8 inches in diameter shall be cut and stacked within the area East of Davis creek where there is no excavation.
- E. Grubbing shall consist of the removal and disposal of stumps, roots, and debris from the work area as shown on the Construction Drawings. Stumps, roots and debris that may contain residuals shall be disposed of with the residual materials. Stumps and roots should be grinded and mixed with residual materials during consolidation. The Contractor shall also remove trees and shrubs where designated on the Construction Drawings. The Contractor shall clear and grub, as necessary, in the material stockpile and borrow areas. Clearing and grubbing for access roads shall also be the responsibility of the Contractor.
  - 1. Any tree that will not, in the opinion of the Engineer, hinder construction of landscaping shall be protected by stakes placed in a circle having a radius of not less than 5 feet as measured from the base of the trunk around the tree. The stakes shall extend at least 4 feet above the existing ground. Each circle shall consist of at least 6 stakes.
- F. The Contractor shall clear undergrowth and deadwood without disturbing subsoil. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations shall be chipped on-site and stockpiled in an area designated by the Engineer. Material to be chipped shall be kept as free of inorganic material as possible.

## 3.2 TOPSOIL REMOVAL

- A. Topsoil shall be removed from the areas within the limits of disturbance as indicated on the Construction Drawings. The depth of topsoil removal shall be determined by the Engineer, as indicated by testing and evaluation of the soils encountered.
- B. Before stripping or removing topsoil, the Contractor shall mow or otherwise remove all heavy grass, weeds, or other vegetation over areas from which topsoil is to be removed.
- C. Equipment and methods of operation employed shall be chosen with the intent to avoid lifting subsoil or other unsuitable material.



# ARCADIS

- D. If soil or weather conditions are unsuitable for topsoil removal, as determined by the Owner, the Contractor shall cease excavation operations until permission to resume stripping and excavation operations is obtained from the Owner.

## 3.3 TOPSOIL STOCKPILING

- A. The Contractor shall keep topsoil separate from other excavated materials. Topsoil shall be completely removed to the required depth from the designated area before beginning excavation or fill placement work in the area. Topsoil shall not be removed to a depth greater than directed by the Engineer.
- B. Topsoil shall be stockpiled on well drained land in the soil stockpile area identified on the Construction Drawings or at a location specified by the Engineer. Topsoil shall be stockpiled in neat conformations with side slopes no steeper than 2H:1V. The surface of each topsoil stockpile shall be shaped and tracked at the end of each working day.
- C. The topsoil stockpiles shall be stabilized by temporary seeding and mulching in accordance with the requirements of Section 02212 (Vegetative Soil and Seeding). Alternatively, the stockpiles may be stabilized by hydroseeding. The stabilization materials and methods shall be approved by the Engineer.

## 3.4 ENVIRONMENTAL PROTECTION

- A. Prohibited Construction Procedures
  - 1. Prohibited construction procedures include, but are not limited to:
    - a. Dumping of spoil material into any wetlands, surface waters or at unspecified locations;
    - b. Indiscriminate, arbitrary or capricious operation of equipment in any stream corridor, wetland or surface waters;
    - c. Pumping of silt-laden water from trenches or other excavations into any surface waters, stream corridor or wetland;
    - d. Damaging vegetation beyond the limit of grading as shown on the Construction Drawings.
    - e. Disposal of trees, shrubs, and other debris in any wetland, surface water, stream corridor or at any unspecified location.

## 3.5 DUST CONTROL

- A. Dust shall be controlled by sprinkling water and sweeping paved areas and by sprinkling water on unpaved areas.

END OF SECTION

## SECTION 02240

### DEWATERING AND WATER TREATMENT

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. Furnish and provide all labor, tools, materials, equipment, and services, and complete all installation and testing work necessary for full operation and use of a temporary water treatment system as described in the Project Documents.
- B. The Contractor will furnish all labor, equipment, and materials necessary to provide for control and collection of all water that comes in contact with paper residuals or polychlorinated biphenyl (PCB) materials as a result of site work activities.
- C. The Contractor will furnish all labor, equipment, and materials necessary to provide for construction, operation, monitoring, and maintaining an on-site water treatment system. The water treatment system will treat all water collected, extracted, or otherwise accumulated during the implementation of the Work described in the Project Documents including, but not limited to, water generated from groundwater within construction excavations; dewatering of excavated materials prior to consolidation; equipment/personnel decontamination; water that comes in contact with exposed paper residuals; stormwater accumulation within excavations, material staging, and containment areas.
- D. Tanks shall be used to store water that is encountered and treated during site work activities. The stored water will be sampled by the Owner or the Owner's Representative and will meet discharge requirements in accordance with the Substantive Requirements Document (SRD – see Part 1.2, References) prior to being discharged to the Kalamazoo River or Davis Creek. If water requires further treatment, the on-site treatment system will be used.
- E. The on-site water treatment system shall be staged and operated within a containment pad. A batch water treatment process shall include settling followed by multimedia filtration and two-stage activated carbon adsorption. A water treatment additive may be used in accordance with the SRD for discharge of water treatment additives. Use of a coagulant or flocculent may be used to assist the sedimentation and/or filtration operations during periods of high water turbidity. The multimedia filters and carbon absorbers shall be trailer-mounted so they can be moved to different areas as the excavation activities progress. Treated water will be stored, sampled by the Owner or the Owner's Representative, and then discharged to the Kalamazoo River and Davis Creek at specific locations determined by the Owner or Owners representative.
- F. A maximum of two treatment systems that discharge at 50 gallons per minute (i.e. 25 gallons per minute each) may be used during construction. The resultant maximum daily discharge rate of treated water encountered during construction shall be approximately 144,000 gallons.
- G. The Contractor shall, to the extent possible, minimize the size of excavation areas to control the quantity of groundwater and stormwater that may require treatment. In

addition, temporary diversion features such as culverts, berms, and diversion swales may be constructed around excavations to control potential run-on from adjacent areas.

- H. Treated waters will be sampled and discharged to the Kalamazoo River or Davis Creek under a project-specific wastewater discharge SRD.
- I. The water treatment system and all related interconnecting piping, valves, controls, gauges, operations, etc. shall be provided as a package/modular system by a single supplier/vendor experienced with such systems.

## 1.2 REFERENCES

- A. SRD and documents related to approval for water treatments additive (to be submitted to the Michigan Department of Environmental Quality [MDEQ] by the Engineer, on behalf of the Owner, prior to construction)
- B. Section 402 of the Clean Water Act (33 USC 1251, et. Seq.)
- C. Part 31 of the Natural Resources and Environmental Protection Act, as amended.

## 1.3 SUBMITTALS

- A. The Contractor will submit a Water Management and Material Dewatering Plan to the Engineer for review and approval. The Contractor will submit all information that substantiates that the proposed system can be operated successfully to meet the performance criteria specified in Part 1.5 of this Specification. Such information includes, but is not limited to, the following:
  - 1. Mobilization, installation, initial startup and testing of the water treatment system
  - 2. Normal (daily) operations, troubleshooting, and shutdown procedures
  - 3. Overall system layout (process flow diagram)
  - 4. Design flow rate and equipment capacity
  - 5. Anticipated peak flows and water storage capacity to accommodate peak flows
  - 6. Anticipated ability to meet effluent limits
  - 7. Estimated quantity of treatment residuals generated for disposal
  - 8. Supporting calculations (such as a mass/flow balance for the proposed Water Treatment Plan)
  - 9. Figure showing location of system components within the Site
  - 10. Technical details relating to the construction and maintenance of the containment pad
  - 11. Cut sheets and technical details for each system component and media

12. Equipment type, size, dimensions, and materials of construction for all system components
  13. Maintenance Plan
  14. Inspection schedules
  15. Recommended spare parts list
  16. Calibration and alignment information
  17. Care and cleaning of surfaces
  18. Pumping and piping types, sizes, and connections
  19. Electrical requirements and service connections
  20. Monitoring and maintenance requirements for system components
  21. Corrective actions and contingency measures for process upsets, exceedances of discharge limits, and non-compliance with performance requirements
  22. Material Safety Data Sheets (MSDSs)
  23. A daily operations log form
- B. Submit a Water Treatment Operations Training Plan to the Engineer for review and approval. The Training Plan will identify means and methods that the Contractor proposes to utilize in training Contractor personnel to operate and maintain the water treatment system.
- C. Submit a report on Initial Startup and Testing within 7 days of completion of the Initial Startup and Testing as specified in Part 3.4.A.
- D. Submit a Water Management and Material Dewatering Plan, as a component of the Remedial Construction and Operations Plan to the Engineer. The Contractor's Water Management and Material Dewatering Plan will contain the following details:
1. Location and methods of extraction points for groundwater/stormwater.
  2. Pump(s), piping, appurtenances to be used to extract accumulated groundwater/stormwater, including numbers, size, flow capacity, and fuel source.
  3. Contractor's anticipated operation of the extraction system, including monitoring, and coordination with other Project activities. Account for dewatering needs outside normal working hours.
- E. The Contractor will maintain (throughout the course of the Construction Project) a written record of the operation and maintenance activities associated with the water treatment and water management systems as specified above in Parts 1.3.A and D, respectively. Such information will be tabulated, updated daily, and submitted on a

weekly basis to the Engineer for review. At a minimum, the summary will include the following information (for each day):

1. Hours of operation.
  2. Volume of water collected, treated, and discharged.
  3. Mode of discharge (i.e., batch or continuous).
  4. Type and frequency of monitoring and maintenance activities (if any).
  5. Other information relevant to the operation, monitoring, and maintenance of the water treatment and water management systems.
  6. Measurements, records and reported water levels in open excavations, sumps, holding tanks and within treatment equipment.
- F. The Contractor will provide water treatment effluent data (e.g., flowrates, volumes, times of discharge, discharge locations, sample data, etc.) to the Owner or the Owner's Representative in a Microsoft® Office compatible format as a part of the Weekly Construction Report.
- G. All water treatment and water management monitoring data will be submitted on CDROM at completion of the Work.
- H. Copies of field notes, including field observations, system inspections and calibration, and all records of maintenance and repair activities conducted, will be provided upon the Owner Representative's request.

## 1.4 QUALITY ASSURANCE/QUALITY CONTROL

- A. Materials and methods will comply with relevant standards, as well as any other standards, codes, or specifications applicable to the design, construction, operation, and maintenance of the water treatment and water management systems.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Where required for management of contact water, trenches, excavations and other parts of the construction site shall be dewatered and kept free of standing water and muddy conditions as necessary for the proper execution of the work.
- B. The Contractor will provide, operate, monitor, and maintain a treatment system that will manage water that may contain the following constituents:
1. Polychlorinated biphenyls (PCBs)
  2. Suspended and dissolved solids.

Information regarding site hydrogeological conditions and groundwater quality for the Site is available in the Remedial Investigation/Focused Feasibility Study Report (MDEQ, 2000), which is provided as supplemental information to the Project

# ARCADIS

Documents. This information identifies the type and general range of constituents that may be present in the water subject to treatment.

- C. The Contractor shall note that there are limitations related to any available groundwater information since seepage conditions may exist that have not been identified. The Contractor is not relieved of the responsibility to control all water, as required to maintain satisfactory conditions in work areas. The Contractor shall provide adequate methods for maintaining satisfactory conditions in work areas by means of earthen berming/diversions (for surface runoff collection/containment), pumping from wells/sump pumps, wellpoint systems, cutoff walls (e.g., sheetpile), or any other measures necessary for particular site conditions.
- D. Treatment/Discharge Requirements
  - 1. The Contractor will operate the water treatment system in accordance with the SRD and the information provided herein.
  - 2. The daily discharge volume of treated water to the Kalamazoo River or Davis Creek will not exceed 144,000 gallons, unless approved by the Engineer (and further approved by the Agencies if required). In the event that stormwater cannot be discharged to the Kalamazoo River or Davis Creek due to a flood or potential flooding conditions, it may be necessary to store, modify the discharge rate and/or method of discharge (batch or continuous) or to stop work in order to avoid contact between water and paper residuals or PCB containing materials. Any determination regarding modifications to the discharge rate, method, and/or location will be made between the Contractor and the Owner's Representative.
- E. The water treatment system will be constructed within a containment area.

## PART 2 PRODUCTS

### 2.1 QUALITY OF PRODUCTS

- A. Standard products: For this Specification, it is assumed that the dewatering and water treatment system will include processes for collection and water storage (influent holding/equalization tanks), particulate settling and/or filtration, oil-water separation and activated carbon adsorption (or similar process). However, the Contractor will select unit processes, as appropriate, to meet the relevant treatment criteria and limitations, and propose it in the Water Management and Material Dewatering Plan for review and by the Engineer for conformance with the Contract documents.

## PART 3 EXECUTION

### 3.1 WATER TREATMENT SYSTEM GENERAL

- A. The water treatment system will be constructed within a containment area to collect miscellaneous water that may leak/leave the water treatment system prior to treatment (e.g., leaks in hose or pipe connections). The containment area will be constructed in accordance with the details provided in the Contractor's approved Remedial Construction and Operations Plan. Accumulated water within the containment area will be collected and subject to treatment.

- B. The Contractor will provide power for, operate, and maintain a temporary on-site water treatment system as described in this Section that will be used to treat liquid waste streams in accordance with the SRD for the project.
- C. The Contractor will maintain lines of communication with the Engineer regarding all discharge issues.
- D. The Contractor will comply with environmental protection requirements in accordance with the Conditions of Work and the SRD.
- E. In the event that the Contractor spills or otherwise releases water which may cause environmental pollution, the Contractor will follow the requirements laid out in the Multi-Area Health and Safety Plan and associated addenda and the Contractor's site specific Health and Safety Plan, which are provided to the Contractor as supporting information, and the Contractor's Operations/Contingency Plan.
- F. The Contractor is responsible for all costs and fees related to the operation and maintenance of the water treatment system (e.g., media change-out, system repairs, etc.). The Contractor will coordinate with the supplier/vendor and provide ancillary services related to, but not limited to, piping; pipe sizes and connections; influent pump flow rate and delivery pressure; electrical requirements; delivery, offloading, assembly, and testing of system components; operations training and maintenance; safety; and cleaning and demobilization of system components. The contractor may dispose of any residuals associated with the water treatment system within the limits of the final cover system in accordance with specification Section 02311 - Residuals Consolidation.
- G. The Contractor will provide electrical service connection(s) as appropriate for operation of the water treatment system. Such service will be installed in accordance with applicable federal, state, and local regulations and requirements.
- H. The Contractor will be responsible for routine inspection of all components of the water treatment system for leaks. Leaks (if observed) will be addressed by the Contractor (including any required cleanup actions) immediately upon observation.

## 3.2 DELIVERY, STORAGE AND HANDLING

- A. Equipment delivered and placed in storage will be protected from weather, excessive humidity, excessive temperature variation and dirt, dust or other contaminants.

## 3.3 COLLECTION AND TREATMENT OF MISCELLANEOUS LIQUIDS

- A. Free liquids collected from dewatering of materials prior to consolidation will be collected and sent through the water treatment system.
- B. All liquid that is not generated from dewatering but is generated due to other operations (including, but not limited to, decontamination water, stormwater and influent groundwater into excavations, stormwater accumulated within work areas) will require handling and treatment. These liquids will be collected and processed through the water treatment system.

- C. The Contractor will properly decontaminate all equipment in accordance with the Specification Section 02131 – Decontamination and Wipe Sampling of Equipment, prior to removing the equipment from the site.

## 3.4 Water Treatment System Operation, Monitoring, and Maintenance

- A. Start-Up Testing / System Optimization – The Contractor will coordinate and perform start-up testing for individual system components, portions of the system, and the overall system as described within this Section and in accordance with the manufacturer's and supplier/vendor instructions. Start-up activities will be described in the Contractor's Water Management and Material Dewatering Plan and reviewed by the Engineer prior to the actual start-up activities. In addition, the Contractor will procure the services of the supplier/vendor of the treatment-related components of the overall system to assist in the performance of start-up activities at the Site and to provide instructions and training to the Contractor related to operation, monitoring, and maintenance of the system. All monitoring will be conducted in accordance with the manufacturer's recommendations. The entire volume of treated water generated during startup and testing will be stored on site until analytical results obtained indicate that the Contractor may discharge the water.
- B. System Operations and Project Coordination – The Contractor will be responsible for operating the water treatment system in accordance with the SRD, specific operating procedures related to the individual system components, the Contractor's other operations, and manufacturer's recommendations. At a minimum, the daily activities to be performed by the system operator (at least once per shift) include, but are not limited to, the following:
  - 1. Control of all tank valves, as necessary, to fill and drain the tanks;
  - 2. Visual inspection of influent and effluent piping to and from the treatment system;
  - 3. Visual inspection of the tanks to avoid overfilling;
  - 4. Visual inspection of the containment area to ensure adequate containment of water that may potentially require containment;
  - 5. Visual inspection of all pumps, fittings, and equipment to ensure that no leakage is occurring;
  - 6. Obtaining readings from the system pressure gauges associated with all treatment systems within the treatment train. Pressure gauge readings may be used to determine when a backwash event or filter replacement is required or that a particular treatment unit is not functioning properly;
  - 7. Obtaining readings from the effluent flow meter to record the total system flow to date and calculate the daily flow total;
  - 8. Measurements, records and reported water levels in open excavations, sumps, holding tanks and within treatment equipment.

The Contractor will closely coordinate and monitor the system operations with respect to potential impacts and disruptions to the overall Project implementation and



schedule. Under no circumstances will the Contractor exceed the storage capacity of the Influent and Effluent Holding Tanks, or discharge any treated effluent to any location without the prior consent of the Engineer. Any determination regarding modifications to the discharge rate, method, and/or location will be made between the Contractor and by the Engineer. The Contractor shall be responsible for any and all modifications required at no additional costs to the Owner.

- C. The Contractor will continuously monitor the operation of the treatment system and at no time leave the system operating without qualified attending personnel present. During the initial dewatering activities, the Contractor may elect to operate the water management and water treatment systems on a continuous basis during non-working hours. If the contractor elects to run the water treatment system on a continuous basis, such a plan must be formally communicated (in writing) to the Engineer for review and approval. Otherwise, the water treatment system must be operated as batches and shall continue to be batched as much as feasibly possible.
- D. As required, the Contractor will perform routine maintenance of the treatment system in accordance with manufacturer's recommendations. During such times, the Contractor will coordinate his activities to minimize interruption to the overall Project implementation. In addition, as part of the routine operation of the water treatment system, the Engineer may collect samples of the treated effluent for laboratory analysis. Downtime (if necessary) related to the laboratory turnaround time (generally two to three days) will be incorporated into the Contractor's planned operation of the system and coordination of related Project activities. If the Contractor elects to take its own samples, this will be done in coordination with the Engineer.
- E. Following conclusion of the water treatment system operations, the Contractor will clean/decontaminate all equipment in accordance with the provisions of Technical Specification 02131 – Decontamination and Wipe Sampling of Equipment, Contractor's Remedial Construction and Operations Plan and the vendor/supplier requirements.

### 3.5 TRAINING

- A. The Contractor will train the staff in the operation and maintenance of the selected/installed equipment and the operation of the water treatment system. Records of equipment and system training will be documented and provided to the Engineer.

### 3.6 SPILL RESPONSE AND DISCHARGE CONTROL

- A. The Contractor will provide on-site equipment and materials for spill response for spills associated with water treatment system construction, operation or maintenance activities. Details for spill response (including a list of equipment and materials) will be included in the Contractor Health and Safety Plan as defined in the Conditions of Work.

### 3.7 CORRECTIVE ACTIONS

- A. At the direction of Engineer, the Contractor will take corrective actions as specified in the Contractor's approved Operations Plan, and as necessary to maintain specified treatment system performance in the event of an upset condition and/or operating conditions that result in non-compliant effluent water quality. During Corrective

Actions, the Contractor may be required to mobilize additional effluent storage tanks and/or repeat startup and testing procedures as specified herein. If the Contractor fails to make these corrections, or if the improved equipment fails to meet the guarantees or specified requirements, the Owner, notwithstanding having made partial payment for work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at the Contractor's expense.

- B. The Contractor will make no claims for delays associated with maintenance, repairs, or documentation to correct performance of the water treatment system.
- C. Contractor will contact the Owner's representative within 4 hours of discovery of problems with water treatment system operations and provide immediate notification of major repairs necessary to keep the system in a normal operational state. Major repairs will be considered as repair/replacement of pumps, motors, treatment units, holding tanks, and control devices.

### 3.8 DECOMMISSIONING

- A. Following completion of water treatment operations, the water treatment system will be decommissioned in accordance with Project Documents (Conditions of Work), Contractor's Operations Plan and the vendor/supplier/manufacture's recommendations.
- B. The Contractor shall be responsible for the proper disposal of wastes generated from treatment and any decontamination water that is created following decontamination of the water treatment system.

### 3.9 DEWATERING OF EXCAVATION AREAS AND CONSOLIDATION MATERIALS

- A. The Contractor's Water Management and Material Dewatering Plan will describe the proposed methods for dewatering and conveyance during construction activities.
- B. In preparing the Water Management and Material Dewatering Plan, the Contractor will incorporate the following conditions:
  - 1. Dewatering activities will be coordinated with the Contractor's overall approach for executing construction activities. The dewatering location(s), sequencing and timing, performance of survey confirmation, placement/compaction of backfill, etc. and other ancillary activities are considerations that should be incorporated into the development of the Water Management and Material Dewatering Plan.
  - 2. Water that accumulates within project work areas will be removed. The Contractor will take precautions to minimize the solids present in extracted water such as constructing a sump and keeping the intake of the pump off the bottom and away from the sidewalls of areas being dewatered. The sump will consist of one of or a combination of the following methods:
    - a. A sump backfilled with washed gravel.
    - b. A perforated vessel (i.e., a corrugated metal pipe or drum), wrapped with a non-woven geotextile fabric and/or filled with gravel.

- c. Straw bales/silt fences around the area where surface water/groundwater/stormwater is being pumped.
3. The extraction rate for each area should consider the volume of water to be removed, the period of time identified by the Contractor for initial dewatering, and the subsequent rate of extraction necessary to maintain dry conditions.
4. To assess the performance of the extraction system, the Contractor will conduct initial system start-up activities (in conjunction with the start-up activities associated with the water treatment system as discussed in Part 3.4.A. These activities are intended to demonstrate and troubleshoot, as necessary, system operations, and to provide planning-level information regarding subsequent operations related to extraction rates/timing and other related operations. Start-up testing will occur once the extraction and treatment system components have been installed and individually tested, as appropriate. The results of the extraction system start-up activities may provide additional information related to extraction rates and timing.
5. The Contractor will provide electrical service connection(s) as appropriate for operation of the water treatment system. Such service will be installed in accordance with applicable federal, state, and local regulations and requirements.
6. A berm will be constructed around soils that require dewatering prior to consolidation to contain water that has drained from the soils;
7. Soils that require dewatering prior to consolidation will be sloped and equipped with a sump to collect water that has drained from the materials, as described above. Drained water will be removed from the sump as required and will be handled as described herein.
8. The location utilized for treatment shall be above the elevation of the 100 year flood and shall be coordinated with other ongoing site operations, including, but not limited to, remedial activities and operations conducted by the Contractor.
9. Excavated materials containing free liquids (i.e., soils excavated from below the water table, sediments, and impacted miscellaneous debris) will require dewatering and possible stabilization prior to consolidation, in accordance with Technical Specification 02311 – Residuals Consolidation. The excavated material that contains free liquid will be dewatered for at least 24 hours using gravity drainage at the dewatering area(s) on site.

### 3.10 SAMPLING

- A. Sampling of the water treatment system will be performed by the Owner's Representative as outlined in the Construction Quality Assurance Project Plan (provided as part of the Project Documents).

### 3.11 DOCUMENTATION

- A. The Contractor will maintain a daily operations log (i.e., tabulated results) in which the process variables described in this Section will be recorded at a minimum frequency

# ARCADIS

of once per shift or more frequently if requested by the Engineer. In addition, all activities related to operation and maintenance of the treatment system will be documented in the daily log. The daily log will be kept at the Site and will be made available to the Engineer on demand. Copies of each daily log sheet will be submitted to the Engineer on a weekly basis.

END OF SECTION

## SECTION 02311

### RESIDUALS CONSOLIDATION

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary to perform residuals consolidation activities as specified in the Project Documents. Residuals consolidation activities shall include, but may not be limited to:
  - 1. Excavating of paper residuals from designated areas;
  - 2. Loading, hauling and stockpiling (if required) excavated paper residuals to consolidation areas; and
  - 3. Placing and compacting paper residuals.

##### 1.2 REFERENCES

- A. ASTM International.(ASTM)
  - 1. ASTM D698 – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
  - 2. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

##### 1.3 SUBMITTALS

- A. The Contractor shall submit the following information to the Owner and the Owner's Representative for review and approval:
  - 1. Residuals Handling Operations Plan; and
  - 2. As-built survey for the top of completed consolidation materials grading performed in accordance with Section 3.7(A) of this Specification.
  - 3. Standard proctor results per ASTM D698 for residuals to be placed and consolidated.
  - 4. In-place moisture-density results per ASTM D6938.

##### 1.4 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

## 1.5 SEQUENCING AND SCHEDULING

- A. The Contractor shall coordinate and sequence earthwork operations to minimize the need for temporary stockpiling of excavated consolidation materials until required for placement and compaction. The Contractor shall make every effort to balance earthwork operations and ensure that consolidation materials designated for fill are immediately placed and compacted.
- B. The Contractor shall allow time for required inspections, tests and approvals when determining consolidation material sequencing and scheduling.

## PART 2 PRODUCTS

NOT USED

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. The Contractor shall verify that survey benchmarks and intended top of consolidation grade elevations are shown on the Construction Drawings.

### 3.2 PREPARATION

- A. Prior to commencing excavation or consolidation activities, the limit of grading, as shown on the Construction Drawings, shall be staked in the field by a Michigan licensed land surveyor in accordance with the requirements of Section 01720 (Construction Surveying).
- B. In accordance with state and local regulations, the Contractor shall notify all area utility companies prior to commencing excavation or residuals consolidation activities.
- C. All site utilities shall be located, identified and clearly marked.
- D. The Contractor shall be responsible for protecting existing wells, utilities and structures from damage. The Contractor shall immediately notify the Engineer of any disturbance or damage to any well, utility, or structure. In the event of damage, the Contractor shall make all repairs and replacements necessary, at no additional cost to the Owner.
- E. Erosion and sediment control measure shall be installed in accordance with Section 01571 (Erosion and Sediment Control) prior to commencing excavation or consolidation activities. The Contractor shall ensure that all local permitting agencies are contacted and substantive permit requirements are met.
- F. Grade breaks and datum locations shall be identified.
- G. Ice and snow shall be removed from any/all excavation area(s).

- H. Bench marks, survey control points, and existing structures shall be protected from damage caused by construction equipment and vehicular traffic.
- I. Open excavations shall be protected by bracing, shoring, sheet piling, or other approved methods required to prevent cave-in or loose soil from falling into excavation.
- J. Graded areas shall be protected from contamination.
- K. The Contractor shall coordinate with the Engineer prior to moving or otherwise disturbing existing wells, utilities and/or structures.
- L. All surface features or obstructions within the excavation areas shall be removed and disposed of as in a manner approved by the Owner.
- M. Prior to placement of residual consolidation materials, samples of the residual materials will be collected and tested for natural moisture content (ASTM D2216) and Standard Proctor (ASTM D698) to further characterize the residual materials, and to allow for assessment of potential dewatering/amendment activities that may be required to achieve placement and compaction conditions consistent with the parameters utilized in the slope stability design. Material samples are anticipated to be collected from the following areas:
  - 1. Area south of Willow Boulevard;
  - 2. Willow Boulevard setback area;
  - 3. Area south of A-Site;
  - 4. A-Site landfill; and
  - 5. Area east of Davis Creek.

The actual locations for material sampling will be determined by the Engineer prior to the start of construction. At this time it is anticipated that one sample will be collected from each area for testing. If material characteristics are determined by the Engineer to vary significantly within each removal area, additional samples will be collected for testing.

- N. Results from natural moisture content and standard proctor results will be used to evaluate the need for conditioning of the residuals (e.g. air-drying, amendment) to control moisture during placement as needed to achieve in-place residual parameters consistent with the engineering slope stability design (i.e. unit weight).
- O. When placing and compacting consolidation materials, the Contractor shall take all necessary precautions to minimize disturbance of any completed and surveyed consolidation areas.
- P. Consolidation materials shall be placed to the grades shown on the Construction Drawings in a manner which promotes drainage and minimizes ponding surface water.

- Q. Excavations shall be kept free of water by pumping, constructing diversion berms and/or ditches to divert water.

### 3.3 EXCAVATING PAPER RESIDUALS AND PCB-CONTAINING MATERIAL

- A. Excavate paper residuals to depths and dimensions shown on the Construction Drawings and as requested by the Engineer.
- B. The perimeter of the excavation areas shall be graded in a manner that prevents surface water drainage into excavation.
- C. The limits of excavation shall be free of loose, soft, organic matter.
- D. The Contractor shall excavate areas to the depths shown on the Construction Drawings. If the excavation depths exceed those shown on the Construction Drawings due to Contractor operating errors, methods of construction, or out of convenience, the Contractor shall correct the excavations to the satisfaction of the Engineer, and at no additional cost to the Owner.
- E. When possible, excavated residuals shall be loaded directly into haulage units and transported to the material placement area. If necessary, excavated consolidation materials may be temporarily stockpiled prior to loading. Stockpiles shall be constructed in a manner which prevents any contact between excavated consolidation materials and clean soil. When loading excavated materials into haulage units, the Contractor shall take all necessary precautions to minimize contamination of exterior of haulage units and loading areas. If the haulage units travel on clean access roads or over clean areas of the site when transporting wet residuals, the interior of the box of the haulage unit shall be lined with 6-mil polyethylene sheeting.
- F. To the extent practical, the Contractor shall perform paper residual excavation and trenching in a manner that limits the amount of contact with residuals that would require decontamination and limits the duration of exposed residual materials.
- G. When requested by the Engineer, wet paper residuals shall be stockpiled and allowed to drain prior to relocation.
- H. Decontaminate construction equipment when visibly contaminated or when moving from a significantly contaminated area to one of lesser contamination for excavation work. Additional decontamination during excavation activities may be required and shall be performed at the request of the Engineer.
- I. Vehicles hauling excavated paper residuals shall not use temporary access roads constructed for cover subgrade construction activities and shall not traverse areas over which clean fill placement has occurred unless previously decontaminated.
- J. Excavated areas shall be backfilled with general fill to existing grade, unless otherwise noted on the Construction Drawings, in accordance with Section 02320 (Fill Materials).
- K. Blend backfill areas with existing landscape features at the intersection of cuts and fills. Provide a gradual slope between disturbed areas and existing grade.



- L. The Contractor shall immediately notify the Engineer of any unexpected subsurface conditions and discontinue working in the area until notified by the Engineer to resume work.
- M. Prior to backfilling, water within excavation areas shall be evaluated to determine proper disposal. Standing water shall be pumped out of excavation in order to maintain dry conditions during backfilling.

## 3.4 CONSOLIDATED MATERIAL PLACEMENT

- A. Excavated paper residuals shall be placed within the limits for consolidation shown on the Construction Drawings.
- B. Liquids collected during consolidation grading shall not be deliberately disposed of within the consolidation material placement areas.
- C. Paper residuals placed within the limit of consolidation shall be graded in a manner which directs surface water runoff to adjacent areas and ultimately infiltrates into adjacent ground. The Contractor will manage consolidation material handling and grading in a manner that prevents runoff or seepage that has contacted paper residuals, from migrating beyond the designated limits for consolidation.
- D. Implement dust control measures as required by applying water and limiting the speed of vehicles on temporary access roads.
- E. Allow precipitation falling within material placement area to infiltrate into ground. If excessive water accumulates within the material placement area, halt placement of paper residuals until either the water infiltrates, or remove the water and handle with other generated wastewaters.
- F. Place consolidation materials in continuous 12-inch compacted thickness layers within the limits of consolidation. The consolidation materials are to be compacted by tracking at a minimum rate of three passes using suitable sized dozer equipment. Additional tracking passes may be required as determined by the Engineer at the time of consolidation material placement.
- G. Excavated paper residuals containing excessive moisture, as determined by the Engineer prior to placement, shall be dried, mixed or solidified (e.g., using Portland cement, fly ash) and spread in thin lifts (i.e., less than 12 inches) within the limits of consolidation.
- H. Large materials that are encountered during excavation that are to be placed within limits of consolidation shall be placed in areas that require fill depths that would provide for a minimum of 12 inches of fill above the material prior to installation of the final cover.
- I. Grinded stumps and wood chips shall be placed and spread within consolidation areas in order to avoid clusters of organic materials.

- J. Residual materials placed within the limit of consolidation shall have a maximum in-place density of 125 pcf, as determined by ASTM D6938. In-place density testing will be performed as described in Section 3.9B of this specification.

## 3.5 PROOF ROLLING

- A. The Contractor shall perform proof rolling of the completed consolidation material surface using a 10-ton, smooth drum vibratory compactor or similar weight/equipment approved by the engineer.
  - 1. Each pass of the roller shall overlap previous pass by a minimum 25 percent.
- B. Soft surface areas not capable of achieving sufficient in-place compaction density shall be re-conditioned or removed and backfilled with other material suitable for compaction.
- C. Proof rolling shall be verified by the Engineer during construction to insure that materials are placed and compacted to meet residual material properties in accordance with the slope stability design (i.e. unit weight). Areas where excessive pumping of consolidated materials is observed (i.e. permanent deflections greater than 1.5 inches) shall be re-rolled. If successive attempts at proof rolling are unsuccessful, the material in question will be removed and the moisture content of the material modified prior to its replacement as backfill and re-rolling.
- D. Upon completion of proof rolling, the Contractor shall verify the in-place residual unit weight in accordance with Section 3.9. Residual materials shall have an in-place unit weight no greater than 125 pcf, and shall have no free-liquid drainage after placement. Any surface water generated during proof-rolling shall be collected and handled in accordance with Technical Specification Section 02240 – Dewatering and Water Treatment.

## 3.6 ENVIRONMENTAL PROTECTION

- A. Construction operations shall be suspended whenever climatic conditions, as determined by the Engineer, are unsatisfactory for excavating or placing consolidation materials to the requirements of this Specification.
- B. Following the periods of heavy rain, the Contractor shall not operate equipment on previously placed material or on approved surfaces until the material has dried sufficiently to prevent excessive rutting.
- C. Consolidation materials shall not be placed in a frozen state, against frozen surfaces or on previously placed frozen material.
- D. Where surfaces or previously placed consolidation materials have been softened or eroded, the Contractor shall remove soft and yielding or otherwise objectionable material and replace it with suitable material approved by the Engineer.
- E. Where stripped surfaces or previously placed materials have been eroded, the Contractor shall allow the area to dry prior to placing additional consolidation materials, compacting and grading as specified by the Engineer.

- F. During excavation and/or transportation of excavated materials, the Contractor shall implement dust control measures as directed by the Engineer.
- G. Where measured or monitored air particulate levels exceed specified limits during excavation and transportation of excavated materials, the Contractor shall implement additional emission control measures to reduce air particulate levels below specific limits.
- H. The Contractor shall decontaminate equipment involved in consolidation grading activities prior to relocating equipment to other areas of the site.

## 3.7 SURVEY

- A. The Contractor shall provide as-built survey information in accordance with Section 01720 (Construction Surveying). The as-built survey information shall include the top of residuals/bottom of gas venting layer elevations on a maximum 50-foot grid. The as-built survey shall include grade breaks and the limit of consolidation.

## 3.8 TOLERANCE

- A. The top of consolidation surface shall be graded within +/- 0.1 foot of the elevations shown on the Construction Drawings.

## 3.9 FIELD QUALITY CONTROL

- A. The Contractor shall perform Proctor and moisture content testing of the residual materials in accordance with American Society for Testing and Materials (ASTM) D698 and D2216 as indicated in Section 3.2.M of this specification or at the discretion of the Engineer based on visual changes in the material observed during construction. Proctor and moisture content testing will be used as a guide to identify whether or not residual materials will require dewatering and/or amendment prior to placement and compaction. Proof-rolling will be performed in accordance with Section 3.5, and in – place density testing according to 3.9.B.
- B. The Contractor shall perform density and moisture testing of the graded residual materials in accordance with ASTM D6938 at a frequency of 2 tests 5,000 square feet per 12-inch thick lift. Additional tests may be required as determined by the Engineer at the time of construction. The required moisture content will be determined based on results of testing performed in Section 3.2.M of this specification and observations during proof-rolling as described in Section 3.5 of this specification.
- C. If the proof-rolling, and/or moisture/density tests indicate that specified residual material properties (i.e. unit weight maximum of 125 pcf, have not been achieved or cannot be obtained with the equipment/procedures being employed, the Contractor shall remove and replace work and modify operations so that the equipment and procedures employed produce the required results. Additional testing that is necessary to further verify material placement conditions, may be requested by the Engineer and shall be performed at no additional cost to the Owner.

## 3.10 EARLY EXCAVATION

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- A. In the event that optimal conditions for excavation are encountered during Phase 1 activities, the Contractor may elect to excavate a portion of the Phase 2 A-Site ancillary areas (specifically the Area East of Davis Creek as indicated in the Construction Drawings) during Phase 1 activities. Residuals excavated from this area shall be stockpiled on the western portion of the A-Site Landfill (within the proposed limits of the cover system) and the Contractor shall incorporate appropriate erosion and sediment controls during the winter months (and prior to installation of the cover system) to protect the exposed materials from washout into the Kalamazoo River and other surrounding areas.

END OF SECTION

## SECTION 02315

### EXCAVATION AND BACKFILL

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary to perform excavation of soils and residuals as well as preparation of subgrade soils as a foundation for placement of fill material. All work shall be performed as specified in the Project Documents.
- B. The work described in this section includes, but is not limited to:
  - 1. Excavation to limits, elevations and depths indicated or depicted on the Construction Drawings;
  - 2. Excavation of clean berm soils deemed acceptable by the Owner for as backfill and final cover protection layer soil;
  - 3. Excavation of paper residuals from site areas outside the limits designated for final cover construction;
  - 4. Implementing measures for stabilizing excavations (if needed) to allow for paper residuals removal and soil backfilling operations;
  - 5. Dewatering (if needed); and
  - 6. Backfilling of excavations with soil fill materials.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.3 EXISTING CONDITIONS

- A. Existing site surface and subsurface conditions, based on the data obtained for the project areas, test borings, and test pits may be obtained from the Owner for the Contractor's review. The Contractor shall review these documents and become familiar with the site soil and groundwater conditions. Topographic and subsurface conditions may vary from those shown or described in the Project Documents. It shall be the Contractor's responsibility to verify the accuracy of all existing conditions shown or described in the Project Documents. The Contractor shall immediately notify the Engineer in writing of variations to the existing conditions indicated in the Project Documents.

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- B. The approximate locations of known underground and aboveground utility lines and structures are shown on the Construction Drawings. The Contractor shall immediately notify the Engineer if other utility lines or structures not shown on the Construction Drawings are encountered during execution of the work.
- C. The Contractor is responsible for the notification and coordination with the Owner and local agency(s) responsible for identification of underground utilities to confirm and/or determine the presence of existing known and potentially unknown underground utilities.

## 1.4 SUBMITTALS AND QUALIFICATIONS

- A. Prior to the start of construction, the Contractor shall submit the following information to the Owner and the Owner's Representative in writing:
  - 1. A site access plan: This plan must describe the equipment to be mobilized, the date and approximate time the equipment will be delivered to the site, the access route to the work areas, and the proposed on-site equipment and material storage area.
  - 2. Proposed equipment and methods of construction, including dewatering, excavation, filling, compaction, and backfilling for the various portions of work: For dewatering, the Contractor shall provide written procedures for diverting or cutting off the flow and for maintaining a dewatered excavation. The Contractor shall not undertake this work until the plan is reviewed and approved by the Engineer. The review shall be for methods only, and the Contractor shall remain responsible for all aspects of the work including, but not limited to, the adequacy and safety of the methods. For excavations greater than 4-feet deep, the Contractor shall also provide methods to be used to stabilize excavations (e.g. trench box, benching, sheet piling) in accordance with OSHA regulations. Methods for providing excavation support will be approved by the Engineer prior to construction.
  - 3. A stockpiling plan: The plan shall indicate the areas of excavation and the anticipated classification of the excavated material (e.g., vegetative soil, paper residuals, etc.). The Contractor shall indicate proposed on-site soil stockpile areas (including dimensions for each soil stockpile area) and stabilization methods. The Contractor shall not implement the stockpiling plan until it is approved by the Engineer.
- B. The Contractor shall notify the Owner and the Owner's Representative in writing at least 7 days in advance prior to commencing work included in this section.
- C. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and the Owner's Representative within 24 hours of the stoppage. Work will not resume without notification to and acknowledgment from the Owner.
- D. The Contractor shall abide by all qualification requirements of the Project Documents.

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## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. All fill materials shall meet the requirements of Section 02320 (Fill Materials).

### 2.2 EQUIPMENT

- A. The Contractor shall only use equipment that has been approved by the Engineer for this work. The Contractor shall submit details of proposed equipment to the Engineer for approval a minimum of 7 days in advance of the Contractor's intention to bring the equipment to the site.
- B. Any equipment that comes in contact with excavated residuals materials shall be decontaminated in accordance with Section 02131 (Decontamination and wipe Sampling of Equipment).

## PART 3 EXECUTION

### 3.1 EXCAVATION

- A. Subsurface materials shall be excavated from work areas to the depth needed to begin placement of backfill materials.
- B. Excavation support will be installed in areas greater than 4-feet deep prior to excavation of materials.
- C. Excavated soil shall be transported to either an active residuals consolidation area or to an area approved by the Engineer for stockpiling.
- D. The Contractor shall stockpile clean excavated material on well drained land in the soil stockpile area identified on the Construction Drawings or at a location specified by the Engineer. Clean, excavated materials shall be stockpiled in neat conformations with side slopes no steeper than 2H:1V. The surface of each stockpile shall be shaped and tracked at the end of each working day. Any excavated material containing paper residuals shall be handled in accordance with Section 02311 (Residuals Consolidation).
- E. If the Contractor encounters a water bearing strata during the excavation, the Contractor shall estimate the flow rate and direction of the origin of the source.
- F. Prior to backfilling, water within excavation areas shall be evaluated to determine proper disposal requirements. Standing water shall be pumped out of excavation in order to maintain satisfactory conditions during backfilling.
- G. The Contractor shall excavate areas to the limits, elevations and depths shown or indicated on the Construction Drawings. If the excavation depths exceed those shown or indicated on the Construction Drawings due to Contractor operating errors, methods of construction, or to suit his convenience, the Contractor shall correct the excavations as requested by the Engineer and at no additional cost to the Owner.

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## 3.2 BACKFILLING

- A. The subgrade shall be prepared, as needed, to make the subgrade suitable, as determined by the Engineer, as a foundation for placement and compaction of backfill material.
- B. In areas where dewatering is required, the Contractor shall take measures to remove water from the subgrade in a manner approved by the Engineer. The resulting subgrade surface shall be free of standing water and shall be suitable as a foundation for compaction of backfill material, as determined by the Engineer.
- C. The Engineer will perform field quality assurance testing of backfill materials. The types and minimum frequencies of quality assurance testing for backfill fill materials are outlined in Section 02320 (Fill Materials). The Contractor shall take the minimum testing frequencies into account in planning his construction schedule.
- D. Perforations
  - 1. Perforations in the backfill materials that must be filled include, but are not limited to, nuclear density test probe locations.
  - 2. Perforations in the fill materials shall be backfilled with similar material. The backfill shall be hand-tamped by the Contractor to the satisfaction of the Engineer.
- E. Defective Areas:
  - 1. If a defective area is discovered in the fill materials, the Engineer will immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the Engineer deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the Engineer will define the limits and nature of the defect.
  - 2. After the extent and nature of a defect has been determined, the Contractor shall correct the deficiency to the satisfaction of the Engineer. The cost of corrective actions shall be borne by the Contractor.
  - 3. Additional testing will be performed the Engineer to verify that the defect has been corrected. This additional testing will be performed before any additional work is allowed in the area of deficiency.

## 3.3 TOLERANCE

- A. The thickness of the fill materials shall be  $\pm 0.1$  foot from the thickness indicated on the Construction Drawings.

## 3.4 SAFETY PROVISIONS

- A. Excavation activities shall be performed in strict accordance with Occupational Safety and Health Administration (OSHA) and all other applicable laws and regulations, as well as the Contractor's Health and Safety Plan for this project. Job site safety is the sole responsibility of the Contractor.

END OF SECTION



## SECTION 02317

### TRENCHING

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary to perform trenching activities as specified in the Project Documents.
- B. The Contractor shall be prepared to perform trenching activities in conjunction with earthworks and other components of the final cover system.
- C. Work of this section includes, but is not necessarily limited to trenching culverts, providing pipe bedding and backfill materials, installing pipes, backfilling and compacting around and over pipes, excavating and backfilling the geosynthetics anchor trenches, and excavating and backfilling horizontal gas collection trenches.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification and in the Project Documents.

##### 1.3 SUBMITTALS

- A. The Contractor shall notify the Owner and the Owner's Representative in writing a minimum of 7 days prior to starting trenching activities. The notice shall state the material to be used, the equipment to be used, the date and time that placement operations will commence, and the name of the person in the field who will be in charge of the trenching activities.
- B. If work is interrupted for reasons other than inclement weather, the Contractor shall notify the Owner and the Owner's Representative a minimum of 24 hours prior to the stoppage and the resumption of work.

#### PART 2 PRODUCTS

##### 2.1 TRENCH BACKFILL MATERIALS

- A. Backfill materials shall meet the requirements outlined in Section 02320 (Fill Materials). Any material that does not meet the requirements outlined in Section 02320 (Fill Materials) will be rejected by the Engineer and shall be replaced by the Contractor with new material in accordance with the requirements of Section 02320 (Fill Materials) at no cost to the Owner.

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## 2.2 EQUIPMENT

- A. The Contractor shall only use equipment that has been approved by the Engineer for this work. The Contractor shall submit details of proposed equipment to the Engineer for approval a minimum of 7 days in advance of the Contractor's intention to bring the equipment to the site.
- B. The Contractor shall furnish, operate, and maintain grading equipment as is necessary to produce uniform layers, sections, and smoothness of grade for compaction and drainage.
- C. The Contractor shall furnish, operate, and maintain compaction equipment as is necessary to produce the required in-place soil density.
- D. The Contractor shall furnish, operate, and maintain water tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities to variable surface widths as required.
- E. Any equipment that comes in contact with excavated residual materials shall be decontaminated in accordance with Section 02131 (Decontamination and Wipe Sampling of Equipment).

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. The Contractor shall identify required lines, levels, contours, and datum.
- B. In accordance with state and local regulations, the Contractor shall notify all area utility companies prior to commencing trenching activities.
- C. All site utilities shall be located, identified and clearly marked.
- D. The Contractor shall be responsible for protecting existing wells, utilities and structures from damage. The Contractor shall immediately notify the Engineer of any disturbance or damage to any well, utility, or structure. In the event of damage, the Contractor shall make all repairs and replacements necessary and to the satisfaction of the Engineer and Owner, at no additional cost to the Owner.
- E. The Contractor shall protect bench marks, survey control points, and existing structures from damage caused by construction equipment and vehicular traffic.

### 3.2 EXCAVATION

- A. The Contractor shall excavate subsoil to the depth required for placement of pipes or geosynthetics.
- B. The Contractor shall cut trenches sufficiently wide to enable installation of pipes or geosynthetics and to allow inspection.

- C. The Contractor shall dewater trenches (including anchor trenches during geosynthetics installation) when necessary.
- D. The Contractor shall maintain trenches in dry condition during installation work.
- E. The Contractor shall excavate soft areas of subgrade and backfill with either bedding material or general fill as requested by the Engineer.
- F. The Contractor shall remove loose or otherwise, unsuitable materials from completed excavation prior to backfilling.
- G. The Contractor shall stockpile, clean excavated material at a locations specified by the Engineer. Clean, excavated materials shall be stockpiled in an orderly fashion with side slopes no steeper than 2 horizontal to 1 vertical. The surface of each stockpile shall be shaped and tracked at the end of each working day. Any excavated material containing paper residuals shall be handled in accordance with Section 02311 (Residuals Consolidation).
- H. The Contractor shall excavate areas to the depths indicated on the Construction Drawings. If the excavation depths exceed those indicated on the Construction Drawings due to Contractor operating errors, methods of construction, or to suit his convenience, the Contractor shall correct the excavations as directed by the Engineer, and at no additional cost to the Owner.

### 3.3 BACKFILLING AND COMPACTING

- A. The Contractor shall backfill and compact excavations in accordance with the Construction Drawings and Section 02320 (Fill Materials).

### 3.4 FIELD QUALITY ASSURANCE

- A. The Engineer will perform field quality assurance testing of trench backfill materials. The types and minimum frequencies of quality assurance testing for trench backfill materials are outlined in Section 02320 (Fill Materials). The Contractor shall take the minimum testing frequencies into account in planning his construction schedule.
- B. Perforations
  - 1. Perforations in the trench backfill materials that must be filled include, but are not limited to, nuclear density test probe locations and hand or machine dug test holes.
  - 2. Perforations in the trench backfill materials shall be backfilled with similar material. The backfill shall be hand-tamped by the Contractor to the satisfaction of the Engineer.
- C. Defective Areas:
  - 1. If a defective area is discovered in the trench backfill materials, the Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the

# ARCADIS

Engineer deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the Engineer will define the limits and nature of the defect.

2. After the extent and nature of a defect has been determined, the Contractor shall correct the deficiency to the satisfaction of the Engineer. The cost of corrective actions shall be borne by the Contractor.
3. Additional testing will be performed the Engineer to verify that the defect has been corrected. This additional testing will be performed before any additional work is allowed in the area of deficiency.

## 3.5 TOLERANCE

- A. The thickness of the trench backfill materials shall be  $\pm 0.1$  foot from the thickness indicated on the Construction Drawings.

## 3.6 SAFETY PROVISIONS

- A. Trenching shall be performed in strict accordance with Occupational Safety and Health Administration (OSHA) and all other applicable laws and regulations, as well as the Contractor's Health and Safety Plan for this project. Job site safety is the sole responsibility of the Contractor.

END OF SECTION

## SECTION 02320

### FILL MATERIALS

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary to install all fill materials as specified in the Project Documents.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. D422 Standard Test Method for Particle-Size Analysis of Soils
  - 2. D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 foot-pounds per cubic foot [ft-lbf/ft<sup>3</sup>] or 600 kilonewton-meters per cubic meter [kN-m/m<sup>3</sup>])
  - 3. D2434 Standard Test Method for Permeability of Granular Soils (Constant Head)
  - 4. D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
  - 5. D5084 10 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
  - 6. D5519 Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials
- B. Michigan Department of Transportation (MDOT) 2003 Standard Specifications for Construction
- C. Michigan Test Method (MTM) 109 – Sieve Analysis of Aggregates

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

# ARCADIS

## 1.4 SUBMITTALS

- A. The following items shall be submitted no later than 14 days prior to the start of construction to the Owner and the Owner's Representative.
  - 1. The Contractor shall submit the following information in order to confirm the suitability of each fill source:
    - a. Name, location and quantity of each source and type of fill material;
    - b. Samples of each source and fill material to be analyzed as described in the Project Documents;
    - c. Laboratory test data in conformance with the requirements of Section 2.1 of this Specification for each source and type of fill material; and
    - d. Proposed equipment to place, grade and compact fill materials.

## PART 2 PRODUCTS

### 2.1 FILL MATERIALS

#### A. General Fill

- 1. General fill shall be used for the soil protection layer and as necessary to backfill areas following excavation.
- 2. General fill placed within 6 inches (above or below) of the final cover geosynthetics shall be free of sharp angular stones and other deleterious materials, and shall have a maximum particle size of 3 inches.
- 3. General fill to be obtained from off-site sources and from on-site soils that are acceptable for re-use (e.g., those soils excavated adjacent to the Sheetpile wall and along the eastern berm at the A-Site Landfill).
- 4. General fill placed used for the soil protection layer shall have a maximum in-place hydraulic conductivity of  $1 \times 10^{-3}$  centimeters per second (cm/s)

#### B. Gas Venting Sand

- 1. Gas venting sand shall be locally available, well-sorted sand, free from angular and elongated objects and deleterious materials, with a relatively small fraction of fines.
- 2. Gas venting sand material shall have a minimum in-place hydraulic conductivity (ASTM D2434) of  $1 \times 10^{-3}$  centimeters per second (cm/s), with less than 5 percent by weight passing the No. 200 sieve.

#### C. Filter Stone

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1. Material placed around the final cover collection piping shall be washed rounded stone, with a  $D_{min}$  of  $\frac{3}{4}$  inches and a  $D_{max}$  of  $1\frac{1}{2}$  inches.
2. Filter stone shall be wrapped with non-woven geotextile as shown on the Construction Drawings.

## D. Select Aggregate Fill

1. Select aggregate fill placed within the gas cutoff trench and adjacent to gas vents and the lateral gas collection pipes shall consist of 3/8-inch washed pea gravel. Pea gravel shall be free of clay, shale, and organic matter.

## E. Habitat Stone

1. Habitat stone material shall be washed, rounded to sub-angular stone with a minimum  $D_{50}$  of 6 inches, and  $D_{min}$  of 3 inches and a  $D_{max}$  of 9 inches.

## F. Riprap:

1. Riprap shall meet the requirements of Section 02372 (Riprap).

## G. Crushed Stone

1. Crushed stone material shall be used for the final cover access road surface and consist of compacted dense grade crushed stone Class II aggregate (MDOT 2003 Standard Specification for Construction Section 902.08) or equal.

## H. Open Graded Stone

1. Open graded stone material shall be used for the construction entrances and consist of dense graded aggregate Class 21AA (MDOT 2003 Standard Specification for Construction Section 902.06) or equal.

## 2.2 GENERAL REQUIREMENTS

A. Each source and type of fill material shall be tested as described below:

Type of Fill	Test Method	Frequency of Testing
General Fill	Standard Test Method for Particle Size Analysis of Soils - ASTM 422	Once per 5,000 cy
General Fill (used for the soil protection layer)	10 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter - D5084	Once per 5,000 cy
Gas Venting Sand	Standard Test Method for Permeability of Granular Soils (Constant Head) - D2434	Once per 5,000 cy
	Standard Test Method for Particle-Size Analysis of Soils - D422	Once per 2,500 cy
Filter Stone	Sieve Analysis of Aggregates - MTM109	Once per 5,000 cy
Select Agregate Fill	Sieve Analysis of Aggregates - MTM109	Once per 5,000 cy
Habitat Stone	Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials - D5519	Once per 5,000 cy
Riprap	See Specification Section 02372 (Riprap)	
Crushed Stone	Sieve Analysis of Aggregates - MTM109	Once per 5,000 cy
Open Graded Stone	Sieve Analysis of Aggregates - MTM109	Once per 5,000 cy

## 2.3 EQUIPMENT

A. The Contactor shall only use equipment that has been approved by the Engineer for this work. The Contractor shall submit details of proposed equipment to the Engineer for review a minimum of 14 days in advance of the Contractor's intention to bring the equipment to the site.



- B. The Contractor shall furnish, operate and maintain grading equipment as is necessary to produce uniform layers, sections and smoothness of grade for compaction and drainage.
- C. The Contractor shall furnish, operate and maintain compaction equipment as is necessary to produce required in-place density and moisture content.
- D. The Contractor shall furnish, operate and maintain water tank trucks, pressure distributors or other equipment designed to apply water the requisite quantities of water uniformly and in a controlled manner to variable surface widths and distances.

## PART 3 EXECUTION

### 3.1 PREPARATION AND RESTORATION

- A. Fill materials shall be inspected prior to placement and all roots, vegetation and other foreign debris shall be removed.
- B. Prior to placing the gas venting layer, material that would protrude more than 1 inch into the gas venting layer shall be removed, regraded or resized. Fill materials placed within 6 inches (above or below) of the final cover geosynthetics shall be free of sharp angular stones and other deleterious materials, and shall have a maximum particle size of 3 inches.
- C. Stones shall not be allowed to form clusters with voids.
- D. Remove ice and snow from subgrade prior to placing any fill materials. Do not place fill materials on frozen, wet or soft subgrade.
- E. Soft areas of unsuitable subgrade are to be replaced with suitable subgrade material.
- F. Prior to placing fill materials, proof-roll subgrade using appropriately sized and type compaction equipment.

### 3.2 PLACEMENT AND COMPACTION

- A. Vegetative Soil
  - 1. The vegetative soil (Section 02922) shall be applied in a single loose lift that once compacted (i.e., compaction that results from placement and grading) of not less than 6 inches in thickness.
  - 2. No compaction is required or allowed other than that which occurs as a result of placement, tracking and grading.
- B. General Fill
  - 1. In areas directly over the geosynthetics, place, grade and compact general fill using an initial minimum lift thickness of 15 inches (compacted thickness and a second lift thickness of a minimum of 9 inches (compacted thickness). In other

areas, place, grade and compact general fill in uniform lift thicknesses to achieve the specified compaction requirements. Completed lift thicknesses following compaction shall not exceed 12 inches, with the exception of the initial lift placed over geosynthetics.

2. Maintain proper moisture content to achieve specified compaction requirements.
3. No compaction is required for general fill material placed over the final cover geosynthetics other than that which occurs as a result of placement and grading.
4. General fill placed in areas other than over the final cover geosynthetics shall be compacted as required during construction based on encountered conditions. General fill may need to be compacted to 95 percent of the maximum standard proctor dry density as determined according to ASTM D698 or by multiple passes of suitably sized equipment.
5. General fill placed over the final cover geosynthetics shall be worked into place from the toe of slope upward to the top of slope to the greatest extent practicable, not exceeding more than 45 degrees from the flowline slope to avoid strain on the geosynthetics material.

## C. Gas Venting Sand

1. Place, grade and compact gas venting sand in uniform lift thicknesses to achieve the specified compaction requirements. Completed lift thicknesses following compaction shall not exceed 12 inches.
2. No compaction is required for gas venting sand other than that which occurs as a result of placement and grading.

## D. Filter Stone

1. Filter stone shall be placed such that it results in a compacted minimum thickness of 6 inches as shown on the Construction Drawings.
2. No compaction is required for filter stone material other than that which occurs as a result of placement and grading.

## E. Select Aggregate Fill

1. Place and spread select aggregate fill in lift thicknesses as required to obtain the specified compaction requirements. Maximum lift thicknesses of 12 inches after compaction shall not be exceeded.
2. No compaction is required for select aggregate fill material other than that which occurs as a result of placement and grading.

## F. Riprap:

1. Riprap shall be installed in accordance with Section 02372 (Riprap).

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## G. Crushed Stone

1. Access road material shall be placed such that it results in a compacted minimum thickness of 8 inches as shown on the Construction Drawings.
2. Access road material shall be compacted to 95 percent of the maximum standard proctor dry density as determined according to ASTM D698.

## H. Open Graded Stone

1. Open graded stone material shall be placed as shown on the Construction Drawings and graded with suitably sized equipment. No specific compaction is required.

## I. General Requirements

1. In general, fill material shall be placed and compacted in horizontal layers no less than 3 inches and not exceeding the thicknesses indicated on the Construction Drawings. The subgrade for placement of fill material shall be approved by the Engineer. Fill material shall not be placed on ground that shall not support the weight of construction equipment.
2. Each layer of soil fill material shall be thoroughly tamped or rolled to the required degree of compaction by mechanical tampers, or vibrators. Successive layers shall not be placed until the layer under construction has been thoroughly compacted.
3. The Contractor shall employ placement and compaction methods that do not disturb or damage piping or geosynthetics.
4. The Contractor will avoid equipment operations (e.g., sudden start-stops, tight turning-pivoting, inadequate protective cover thicknesses) that could result in damage to underlying materials (i.e., completed placement of soils/aggregates, piping, geosynthetics, etc).
5. Any observed equipment operations that, in the opinion of the Engineer, could lead to damage of underlying materials, will be investigated by the Engineer. Underlying materials that are identified as being damaged due to questionable equipment operations will be replaced in full accordance with the Project Documents at no additional cost to the owner (including those associated project schedule delays).
6. The Contractor shall not use heavy compaction equipment (i.e., greater than 5 pounds per square inch [psi] ground pressure) over piping or geosynthetics that area covered by less than 15 inches of fill material.
7. Trucks or other heavy equipment shall not be operated over any fill layer until the minimum thickness of soil fill has been placed and properly compacted by tampers or other approved method.

8. The Contractor shall begin placing fill materials at the lowest elevation of the area to be backfilled.
9. Drainage of the areas being backfilled shall be maintained at all times.
10. Where required, the Contractor shall add water to the fill materials in order to meet compaction requirements at no additional expense to the Owner. If, due to rain or other causes, the material is too wet for satisfactory compaction, the fill materials shall be allowed to dry or be removed as required, prior to compaction.
11. At the end of a day, the Contractor shall track the slope with a bulldozer perpendicular to the slope to help minimize erosion.

### 3.3 FIELD TESTING AND QUALITY CONTROL

- A. In-place density tests (using ASTM D6938) shall be performed by an independent testing laboratory at the Contractor's expense. Tests will be required at a minimum of one test per each lift of backfill placed or at a frequency of 1 passing test per 5,000 square feet of subgrade, 100 cubic yards of soil fill, or 100 linear feet of pipe bedding, whichever results in the greatest frequency.
- B. The Engineer may request additional in-place density tests to ascertain conformance with the compaction requirements presented in Section 3.2 of this Specification.
- C. Material thicknesses may be confirmed by as-built survey or the Engineer may approve material thickness by hand-shoveling and measuring the observed material thickness.

### 3.4 CRITERIA AND TOLERANCES

- A. Fill materials shall be constructed to such heights as to allow for post-construction settlement. Any settlements that occur before final acceptance of the Contract shall be corrected to make the backfill conform to the lines and grades shown on the Construction Drawings.
- B. The thickness of the fill materials shall be  $\pm 0.1$  foot from the thickness indicated on the Construction Drawings.

END OF SECTION

## SECTION 02372

### RIPRAP

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, equipment, and materials, and shall perform all work necessary to place a protective covering of erosion-resistant riprap as specified in the Project Documents.
- B. The Contractor shall be prepared to install the riprap in conjunction with earthworks and other components of the final cover system.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
  - 2. C127 Standard Test Method for Density, Relative Density (Specific Gravity, and Absorption of Coarse Aggregate
  - 3. C666 Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.4 SUBMITTALS

- A. The Contractor shall submit the following information at least 14 days prior to riprap installation to the Owner and the Owner's Representative:
  - 1. Particle size distribution of proposed riprap; and
  - 2. Proposed sources of riprap and quantity of available material from each source.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and transport riprap at all times in a manner and with equipment that will prevent intermixing of riprap with other materials.
- B. Stockpile riprap at the Site in locations approved by the Engineer.
- C. Minimize stockpiling requirements. Transport riprap from source directly to final position where possible.

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- D. Exercise care in loading, hauling, and unloading riprap to prevent crushing and splitting that would lead to rejection.

## PART 2 PRODUCTS

### 2.1 RIPRAP

- A. Stone used for riprap shall be hard; durable; angular in shape; resistant to weathering and to water action; free from overburden, spoil, shale and organic material; and shall meet the gradation requirements specified. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone or boulders shall not be accepted for use unless allowed by the Engineer. Shale and stone with shale seams are not acceptable.
- B. The sources from which the stone shall be obtained shall be selected by the Contractor for approval by the Engineer at least 14 days in advance of installation. The acceptability of the stone shall be determined by service records and/or by suitable tests, as required by the Engineer. If testing is required, suitable samples of stone shall be taken in the presence of the Engineer prior to mobilization to the site. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from that quarry.
- C. Riprap shall have the following approximate gradation, unless otherwise shown on the Construction Drawings:

Application	Maximum Stone Size ( $d_{max}$ )	$d_{50}$
Riprap Apron (Culverts)	12 inches	8 inches
Riprap Apron (Final Cover Collection Pipe Outlets) and Reno Mattress	5 inches	4 inches

- D. Each load of riprap shall be reasonably well graded from the smallest to the maximum size specified.
- E. In addition to meeting the gradation requirements set forth in this Specification, riprap shall consist of stones shaped as nearly as practicable in the form of right rectangular prisms.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Excavate to the lines and grades required for placement of the riprap.
- B. Non-woven geotextile shall be placed over areas to receive riprap in accordance with the Construction Drawings and Section 02076 (Geotextile).

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## 3.2 PLACEMENT

- A. Riprap shall be placed to the limits and layer thicknesses shown on the Construction Drawings. The completed thickness shall be within 2-inches (plus or minus) of the specified layer thickness.
- B. Place riprap with care so as not to damage the underlying geotextile. Do not drop riprap from a height greater than 12 inches above the prepared subgrade.
- C. Slopes or ditches to be protected by riprap shall be free of brush, vegetative soil, trees, stumps, and other objectionable material and shall be dressed to a smooth and uniform surface. All soft or spongy material will be removed as determined by the Engineer and replaced with approved material and compacted as specified.
- D. Stone for riprap shall be placed on the prepared surfaces in a manner that shall produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thicknesses shown on the Construction Drawings. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying materials. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be allowed.
- E. Riprap shall be so placed and distributed such that there are no large accumulations of either the larger or smaller sizes of stone.
- F. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.
- G. Unless otherwise allowed by the Engineer, riprap shall be placed in continuous progression with the construction of the embankment. The Contractor shall maintain the riprap protection until accepted, and any material displaced by any cause shall be replaced to the lines and grades shown on the Construction Drawings at no additional cost to the Owner.
- H. Riprap shall be placed so that the dimension approximately equal to the layer thickness is perpendicular to the slope surface, and so that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest stones shall be placed at the bottom of the slope. The riprap shall be properly aligned and placed so as to minimize void spaces between adjacent stones. The spaces between the stones shall be filled with spalls of suitable size.
- I. All sediment deposited within the riprap following installation shall be promptly removed by the Contractor.

## 3.3 ENVIRONMENTAL RESTRICTIONS

- A. The Contractor shall suspend operations whenever climatic conditions are unsatisfactory for placing riprap as specified in this Section.

END OF SECTION

## SECTION 02522

### WELL INSTALLATION

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals necessary to complete the work specified in the Project Documents. The work shall include, but may not be limited to:
  - 1. Clearing of all proposed drilling locations for underground or overhead utilities.
  - 2. Installation of monitoring wells to specified depths using hollow stem auger or rotasonic drilling methods (as specified by the Engineer).
  - 3. Collection and disposal of waste material generated during well installation procedures.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: Agree to participate in, and conform with, all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.3 SUBMITTALS

- A. The Contractor shall provide a well installation record for each location for submittal to the Engineer. Required data for each location include: drilling equipment, drilling depth, an inventory of the well materials installed, depth of placement of each well component, and the composition and volume of grout used.

#### PART 2 PRODUCTS

##### 2.1 WELL MATERIALS

- A. Monitoring well riser pipe will consist of 2-inch diameter, Schedule 40 PVC. The well screen will be 2-inch diameter, "wire"-wrapped, polyvinyl chloride (PVC) with a 0.010 or 0.020 slot size, depending on the encountered materials at the screen placement depth. A 7-foot screen length will be used to construct the water table wells, and if deeper wells are installed a 5-foot screen length will be used. Wells will be installed with an outer casing of 4-inch diameter steel or Schedule 40 PVC to isolate the screened interval from residual material that could otherwise be pulled down by the drilling process. A flush mount protective casing shall be installed over the 4-inch outer casing.

##### 2.2 WELL ANNULAR MATERIALS



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- A. The sand pack will consist of graded silica sand with a grain size selected based on the observed grain size of the soil adjacent to the screened interval, and the screen slot size.
- B. The bentonite seal shall consist of pellet bentonite. The pellets will be hydrated in place at locations with the seal placed above the water table.
- C. Cement/bentonite grout shall be prepared at a ratio of one bag (94 pounds) of Type I or Type II Portland cement to 3 to 5 pounds of bentonite powder mixed with 7.8 gallons of potable water.
- D. The surface seal shall consist of concrete.

## PART 3 EXECUTION

### 3.1 WELL INSTALLATION

- 1. The boring shall be advanced while collecting continuous soil samples for visual observation.
- 2. An outer 4-inch interior diameter casing will be tremie-grouted in place to isolate the screened interval from any residual material that could be encountered above the intended depth of well placement. The grout will be allowed to cure for a minimum period of 24-hours. The boring will continue to be advanced through the 4-inch casing to the design depth of the bottom of the well.
- 3. [Note that the selection of well installation depth is currently being discussed and will be presented in an addendum to the Groundwater Monitoring Plan.] Once the boring has been advanced to the total well depth, a 2-inch thick sand pad will be placed at the base of the boring. The well components shall be threaded together, and the well string placed in the boring. For the water table wells, 5-feet of the 7-foot screen will be placed below the estimated water table elevation. As the drill string is withdrawn, the annular materials will be placed sequentially using a tremie pipe to avoid bridging: sand pack extending 2-feet above the well screen, 2-foot thick bentonite pellet seal, cement/bentonite grout to within 2-feet of the ground surface, followed by a cement seal placed around the flush-mount well cover at the ground surface. The surface seal is constructed to slope away from the well to promote drainage.

### 3.2 WASTE DISPOSAL

- A. All waste materials generated during well installation activities shall be collected and contained on site in roll-off boxes or 55-gallon drums for future analysis and appropriate disposal. It is anticipated the waste material will be incorporated into the landfills.

END OF SECTION

## SECTION 02526

### WELL ABANDONMENT

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals necessary to complete the work specified in the Project Documents. The work shall include, but may not be limited to:
  - 1. Removal of all monitoring wells, cement pads, and well protectors from each existing monitoring well location at the site.
  - 2. Grouting holes left in place after monitoring well demolition.
  - 3. Collection and disposal of material generated during well decommissioning procedures.

##### 1.2 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.3 SUBMITTALS

- A. The Contractor shall provide a well abandonment record for each location to the Owner and the Owner's Representative for submittal to the Michigan Department of Natural Resources and Environment (MDNRE). Required data for each location include: drilling equipment, drilling depth, an inventory of the well materials removed, and volume of grout used.

#### PART 2 PRODUCTS

##### 2.1 CEMENT/BENTONITE GROUT

- A. Cement/bentonite grout shall be prepared at a ratio of one bag (94 pounds) of Type I or Type II Portland cement to 3 to 5 pounds of bentonite powder mixed with approximately 7 gallons of potable water.

#### PART 3 EXECUTION

##### 3.1 WELL ABANDONMENT

- 1. The cement pad and the well protector around the monitoring pad shall be removed and the immediate area around the monitoring well dug out. The riser pipe shall be cut off approximately 1 foot above ground surface.

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2. Hollow stem augers (minimum inside diameter of 4 inches) shall be placed over the riser pipe of the monitoring well before commencement of drilling. Drilling shall continue until the final depth to which the monitoring well was installed is reached. The well materials shall then be removed (pulled) from the augers. In the event that difficulties are encountered during removal of the well materials, remaining portions of the well may be grouted in place.
3. A cement/bentonite grout shall be placed from the bottom of the borehole to the top of the augers. As each flight of augers is removed from the ground, the cement/bentonite grout shall continue to be placed in the augers, to the top. This shall continue until all augers have been removed from the borehole.

## 3.2 WASTE DISPOSAL

- A. All material generated during well decommissioning procedures shall be collected and contained on-site. This material will be disposed of with residual materials generated during other site excavation activities.

END OF SECTION

## SECTION 02551

### POLYVINYL CHLORIDE (PVC) PIPE

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the construction and installation of the polyvinyl chloride (PVC) pipe, as specified in the Project Documents.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. D1784 Standard Specification for Rigid PVC Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds
  - 2. D1785 Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120
  - 3. D2467 Standard Specification for PVC Plastic Pipe Fittings, Schedule 80

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.4 SUBMITTALS

- A. Prior to PVC pipe installation, the Contractor shall submit the following information to the Owner and the Owner's Representative:
  - 1. Shop drawings which include the following information pertaining to the landfill gas vents:
    - a. Vent riser connection details between the perforated PVC pipe section and solid PVC pipe section;
    - b. Final cover/vent seal details; and
    - c. Pipe connections to above-grade piping.
  - 2. Manufacturer's data sheets for pipe materials, including stock density, flexural modules and tensile strength.
  - 3. Results of manufacturer's test results.

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4. Manufacturer's installation, handling, storage, and repair instructions.
- B. Following completed installation of the gas vents, the Contractor shall submit the following information to the Owner and the Owner's Representative:
  1. Record drawings indicating, at a minimum:
    - a. Locations of installed gas vents;
    - b. Type of gas vent installation (e.g., vertical vent, lateral vent); and
    - c. Depth to bottom of gas vents.

## 1.5 SEQUENCING AND SCHEDULING

- A. Gas vent installation shall commence following placement of grading of consolidated residuals in the area of the gas vent, but prior to placing final cover geosynthetics.
- B. When determining construction sequencing, the Contractor shall make provisions for placing excavated or augured waste cuttings within the landfill, beneath the gas venting layer.

## PART 2 PRODUCTS

### 2.1 GENERAL PVC PIPE AND FITTINGS

- A. PVC pipe shall be supplied in standard laying lengths not exceeding 40 feet.
- B. PVC pipe shall be furnished either in solid or perforated section as specified in this Specification and on the Construction Drawings. If pipes are manufactured unperforated and are to be installed perforated, the Manufacturer shall drill perforations into the pipe prior to delivery to the site.
- C. PVC pipes and fittings shall be homogeneous throughout, free of visible cracks, holes (other than intentional manufactured perforation), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index and other physical properties.
- D. Fittings at the end of pipes shall consist of PVC end caps unless indicated otherwise in this Specification and/or on the Construction Drawings.
- E. The following shall be continuously printed on the pipe, or spaced at regular intervals:
  1. Name and/or trademark of the pipe manufacturer;
  2. Nominal pipe size;
  3. Schedule;
  4. Manufacturing Standard Reference (e.g., ASTM D1785); and

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5. A production code from which the date and place of manufacture can be determined.

## F. Fittings

1. Pipe fittings shall be manufactured in accordance with ASTM D2467 and shall have a Schedule rating as recommended by the pipe manufacturer and fit 4-inch diameter, Schedule 80 PVC pipe.

## G. Joints

1. Provide socket type at all locations.
2. Use solvent cement.
3. No joint solvent shall be used for joint socket connections.

## 2.2 GAS VENTS

### A. Perforated PVC Pipe

1. Perforated pipe shall be a 4-inch diameter, Schedule 80 pipe manufactured from a Type I, Grade I PVC compound with a Cell Classification of 12454 per ASTM D1784. The pipe shall be manufactured in strict compliance to ASTM D1785, consistently meeting and/or exceeding the Quality Assurance test requirements of this standard with regard to material, workmanship, burst pressure, flattening, and extrusion quality.
2. Where indicated on the Construction Drawings, the perforated pipe shall have perforations consisting of 4 rows of drilled 1/4-inch diameter holes, spaced every 4 inches and staggered along the pipe.
3. Pipe end cap shall be manufactured from Schedule 80 PVC and shall be perforated with less than 1-inch diameter holes.
4. Pipe connections shall be solvent welded together.

### B. Solid PVC Pipe

1. Solid shall be a 4-inch diameter, Schedule 80 pipe manufactured from a Type I, Grade I PVC compound with a Cell Classification of 12454 per ASTM D1784. The pipe shall be manufactured in strict compliance to ASTM D1785, consistently meeting and/or exceeding the Quality Assurance test requirements of this standard with regard to material, workmanship, burst pressure, flattening, and extrusion quality.
2. Vent cap shall be perforated and welded to 4-inch diameter pipe elbow as shown on the Construction Drawings.
  - a. Perforations shall consist of drilled 1/2-inch diameter holes, spaced a 1/4-inch apart over the entire vent cap.

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## 2.3 HANDLING AND STORAGE

- A. Care shall be exercised when transporting, handling and placing PVC pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.
- B. Ropes, fabric or rubber-protected slings and straps shall be used as necessary when handling PVC pipe. Slings, straps, etc. shall not be positioned at joints. Chains, cables or hooks shall not be inserted in the pipe ends as a means of handling pipe.
- C. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Under no circumstances shall pipe or fittings be dropped into trenches.
- D. PVC pipe shall be stored on clean level ground, free of sharp objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. The pipes shall be stored out of direct sunlight.
- E. The maximum allowable depth of cuts, gouges or scratches on the exterior surface of PVC pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. The Contractor shall remove sections of pipe with excessive cuts, gouges or scratches and join the ends of the pipe at no additional cost to the Owner.
- F. Whenever pipe installation is not actively in progress, the open ends of previously installed pipe shall be closed using a watertight plug.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Prior to PVC pipe installation, the Contractor shall:
  - 1. Verify that all required safety provisions necessary to perform installation activities are in place and have been tested.
  - 2. Verify all surfaces have been prepared in accordance with the Construction Drawings.

### 3.2 INSTALLATION

- A. All PVC pipe and fittings shall be installed in accordance with the manufacturer's instructions.
- B. The interior of all pipe and fittings shall be inspected by the Contractor, and any foreign materials shall be completely removed from the pipe interior before it is moved into final position.
- C. Field-cutting of pipes, where required, shall be made with a machine specifically designed for cutting pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cut ends shall be tapered and sharp edges filed off smooth. Flame cutting shall not be used.

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## 3.3 TOLERANCES

- A. The maximum allowable vertical gas vent pipe variation from true position plumb is 0.25 inch.

## 3.4 FIELD QUALITY CONTROL

- A. The Engineer shall inspect the PVC pipe to verify the integrity of pipe connections, geomembrane/pipe seal, and end cap installation.

## 3.5 PRODUCT PROTECTION

- A. The Contractor shall use all means necessary to protect all prior work and all materials and completed work of other Sections.
- B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Engineer and at no additional cost to the Owner.

END OF SECTION



## SECTION 02618

### SOLID WALL HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for installation of all high density polyethylene (HDPE) solid wall pipe, fittings, and appurtenances as specified in the Project Documents.
- B. The Contractor shall be prepared to install the HDPE pipe and fittings in conjunction with the earthwork and other components of the final cover system.
- C. The work shall include procurement, installation, connection, and testing of all piping.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. D1248 Standard Test Method for Polyethylene Plastics Molding and Extrusion Materials
  - 2. D2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
  - 3. D2837 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
  - 4. D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
  - 5. F714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
- B. Geosynthetic Research Institute (GRI):
  - 1. GM 5 Seam Constant Tensile Load (SCTL) Test for Polyolefin Geomembrane Seams

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

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## 1.4 SUBMITTALS

A. The following items shall be submitted to the Owner and the Owner's Representative for review no less than 30 days prior to the start of HDPE pipe installation or not less than 15 days prior to delivery of the HDPE pipe to the site, whichever is earliest.

1. The Contractor shall submit the following information in writing:
  - a. Detailed shop drawings of all HDPE pipe and fittings, which include:
    - 1) Pipe material specifications;
    - 2) Pipe joint techniques; and
    - 3) Pipe and fitting details.
  - b. List of materials to be furnished;
  - c. Name(s) of supplier(s);
  - d. Proposed material delivery dates; and
  - e. Resumes of certified pipe welders.
2. The HDPE Pipe Manufacturer shall submit the following information in writing:
  - a. Handling, storage and installation guidelines;
  - b. Certification of compliance with these Specifications for all materials delivered to the site;
  - c. Certificate stating the specific resin, its source, and the information required by ASTM D1248;
  - d. Certification that no recycled compound has been added to the resin except that generated in the HDPE Pipe Manufacturer's own plant from resin of the same specification from the same raw material; and
  - e. Certification verifying stress regression testing was performed on the delivered materials in accordance with ASTM D2837. The supplied HDPE pipe shall have a minimum Hydrostatic Design Basis (HDB) of 1,600 pounds per square inch, as determined in accordance with ASTM D2837.

## 1.5 WARRANTY

The HDPE Pipe Manufacturer and Contractor shall furnish a standard written warranty against defects in materials and workmanship in accordance with ASTM D3350 and ASTM F714. Warranty conditions concerning limits of liability will be evaluated by the Engineer and must be acceptable to the Owner.

# ARCADIS

## PART 2 PRODUCTS

### 2.1 HDPE RESIN PROPERTIES

- A. The HDPE pipe and fittings shall be manufactured from new, high performance, high molecular weight, high density polyethylene resin conforming to ASTM D1248 (Type III, Class C Category 5, Grade P 34), ASTM D3350 (Cell Classification PE 345434C), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. In plant blending of non-compounded resins shall not be permitted.
- B. The polyethylene compound shall contain a minimum of 2 percent carbon black.
- C. The polyethylene compound shall have a minimum resistance of 5,000 hours when tested for environmental stress crack in accordance with requirements of GRI GM 5.

### 2.2 SOLID WALL HDPE PIPE AND FITTINGS

- A. All HDPE pipe and fittings shall comply with the requirements of ASTM D3350.
- B. HDPE pipe shall be supplied in standard laying lengths not exceeding 50 feet.
- C. All HDPE Pipe and Fittings shall have a minimum HDB of 1,600 pounds per square inch when determined in accordance with ASTM D2837.
- D. HDPE pipe shall be furnished non-perforated or perforated as specified on the Construction Drawings. If pipes are manufactured unperforated and are to be installed perforated, perforations shall be drilled into the pipe prior to delivery to the site. Perforations shall be in accordance with the details provided in the Construction Drawings.
- E. HDPE pipe and fittings shall be homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.
- F. The pipe interior surface shall be free of shavings or burrs and shall be joined using butt-fusion (thermo-weld) joints.
- G. Pipe end fittings shall consist of HDPE end caps unless indicated otherwise on the Construction Drawings.

### 2.3 IDENTIFICATION

- A. The following shall be printed or marked on the pipe at regular intervals:
  - 1. Name and/or trademark of the HDPE Pipe Manufacturer;
  - 2. Nominal pipe size;
  - 3. Dimensional ratio (DR);

# ARCADIS

4. The letters PE followed by the polyethylene grade per ASTM D1248, followed by the Hydrostatic Design basis in 100's of pounds per square inch (psi) (e.g., PE 3408);
5. Manufacturing Standard Reference (e.g., ASTM F714); and
6. A production code from which the date and place of manufacture can be determined.

## 2.4 PIPE BEDDING MATERIAL

- A. During installation of the HDPE pipe, the pipe bedding material used shall meet the requirements in Section 02320 (Fill Materials) for select aggregate fill material.

## 2.5 TRANSPORTATION

- A. Transportation of HDPE pipe and fittings shall be the responsibility of the Supplier. The Supplier shall be liable for all damage to the HDPE pipe and fittings incurred prior to and during transportation to the site.

## PART 3 EXECUTION

### 3.1 HANDLING AND PLACEMENT

- A. The Contractor shall exercise care when transporting, handling and placing HDPE pipe and fittings, such that the pipe will not be cut, kinked, twisted, or otherwise damaged.
- B. Ropes and fabric or rubber-protected slings and straps shall be used as necessary when handling HDPE pipe. Slings, straps, etc., shall not be positioned at butt-fused joints. Chains, cables, or hooks shall not be inserted into the pipe ends as a means of handling pipe.
- C. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Under no circumstances shall pipe or fittings be dropped into trenches or dragged over sharp, protruding, or cutting objects.
- D. HDPE pipe shall be stored on clean level ground, preferably turf or sand, free of sharp or protruding objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports. The pipes should be stored out of direct sunlight.
- E. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of HDPE pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges, and scratches. Sections of pipe with excessive cuts, gouges, or scratches shall be removed and the ends of the pipe rejoined at no cost to the Owner.

# ARCADIS

- F. Whenever pipe installation activities are not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.
- G. Where pipes penetrate through geomembranes, an effective seal shall be established in accordance with the details shown on the Construction Drawings.

## 3.2 INSTALLATION

- A. Prior to installation, the Contractor shall carefully examine all HDPE pipe and fittings for cracks, damage. Defective materials shall be immediately removed from the site and replaced at no cost to the Owner.
- B. All HDPE pipe and fittings shall be installed in accordance with the HDPE Pipe Manufacturer's recommendations.
- C. The interior of all HDPE pipe and fittings shall be inspected and any foreign material shall be completely removed from the HDPE pipe interior before it is moved into final position.
- D. Field-cutting of HDPE pipes, where required, shall be made with a machine specifically designed for cutting HDPE pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cut ends shall be tapered and sharp edges filed off smooth. Flame cutting shall not be used.
- E. All HDPE pipe and fittings shall be laid or placed to the lines and grades shown on the Construction Drawings, with bedding and backfill material placed appropriately, as shown on the Construction Drawings and as specified in this Section.
- F. No HDPE pipe shall be laid until the Engineer has approved the bedding conditions.
- G. No HDPE pipe shall be brought into position until the preceding length has been bedded and secured in its final position.
- H. Blocking under piping shall not be permitted unless specifically allowed by the Engineer for special conditions.
- I. The Contractor shall provide all necessary adapters and/or connection pieces required when connecting different types and sizes of HDPE pipe or when connecting HDPE pipe made by different manufacturers.

## 3.3 JOINTS AND CONNECTIONS

- A. The HDPE pipe shall be joined using thermal butt-fusion joint techniques. All joints shall be constructed in strict compliance with ASTM D2657 and the HDPE Manufacturer's recommendations.

## 3.4 TOLERANCES

- A. The maximum allowable vertical HDPE pipe variation from true position plumb is 0.25 inch.

END OF SECTION

## SECTION 02820

### GALVANIZED CHAIN LINK FENCE

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary for the installation and repair of any chain link fence as specified in the Project Documents.
- B. The Contractor shall install warning signs at 200-foot intervals around the perimeter fenceline.

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless
  - 2. A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
  - 3. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - 4. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - 5. F567 Standard Practice for Installation of Chain-Link Fence

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.4 SUBMITTALS

- A. The Contractor shall submit the following information no later than 14 days prior to installation to the Owner and the Owner's Representative:
  - 1. Samples of fabric, wires, ties, and post sections;;
  - 2. Drawing, showing details of fence height, size of post, rails, braces, gates, accessories, and grounding equipment; and
  - 3. Copies of the manufacturer's certification.

# ARCADIS

4. Proposed locations and wording for warning signs

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. The contractor shall evaluate the material type of the existing on-site chain link fence and propose new materials that are of the same material type, dimension, weight, wire type and with the same associated accessories (e.g., barbed wire, stretcher bars, tension wire, gates, footings and wire ties, etc.).

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### A. General

1. Installation shall be in accordance with ASTM F567 and the Manufacturer's recommendations, unless otherwise modified by the Contractor and approved by the Engineer.

#### B. Gates

1. Install true to opening, plumb, and to open as shown on Construction Drawings.
2. Adjust hardware for smooth operation.

- C. The area shall be left neat and free of any debris caused by the erection of the fence.

END OF SECTION

# ARCADIS

## SECTION 02921

### RESTORATION PLANTINGS

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. The Installer shall furnish all labor, materials, tools, supervision, transportation and installation equipment necessary for the installation and establishment of vegetation as specified in the Project Documents. The Installer shall be under direct contract to the Contractor.
- B. The Work includes the application of seeds and planting of trees and shrubs within the restoration areas: Riparian Corridor, Emergent Wetland, Forested Wetland, Forested Upland, and Tree Screen
- C. The Contractor shall perform all post-construction activities necessary for the establishment of vegetative growth as specified herein on all seeded and planted areas until final acceptance is given by the Owner as described in Section 3.9 of this Specification.

##### 1.2 REFERENCES

- A. United States Clean Water Act Section 404
- B. Section Part 301, Inland Lakes and Streams, of the Michigan Natural Resources and Environmental Protection Act (NREPA)
- C. Part 91, Soil Erosion and Sedimentation Control, of NREPA
- D. Part 303, Wetlands Protection, of NREPA
- E. Rivers and Harbors Act
- F. Section 01571 – Erosion and Sediment Control
- G. Section 02315 – Excavation and Subgrade Preparation
- H. Section 02320 – Fill Materials
- I. Section 02922 – Vegetative Soil, Seeding, and Mulch

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the and in the Project Documents.



# ARCADIS

## 1.4 QUALIFICATIONS

### A. Contractor:

1. The Vegetation Installer shall meet the qualification requirements of this Specification.

### B. Vegetation Installer:

1. Company specializing in work of this section with a minimum of 5 years of experience in planting and establishing wetland and upland plant communities with documented references. Personnel used to perform the installation of plant materials shall also have occupational experience in vegetation restoration projects.
2. Obtain seed stock only from established Vendors capable of providing seed quantities adequate to complete this project. Seed Vendors will be required to provide the data requested under Section 1.5(A) of this Specification prior to use of that seed.
3. Obtain planting stock only from established Vendors capable of providing plant stocks in quantities and at quality levels adequate to complete the project. Plant Vendors will be required to provide the data requested under Section 1.5(B) of this Specification prior to use of that stock.

## 1.5 SUBMITTALS

- A. Certificates: submit certificates from seed vendors for each seed mixture or type of seed required. The certificates shall include the following: the botanical name and common name, percentage of seeds by weight in a mixture, purity of the seed, germination percentage, the amount of undesirable plant seeds present in the mixture, date of production, date of packaging and name and address of Vendor(s). Submit at least 4 weeks prior to time of planting to the Owner and the Owner's Representative.
- B. Certificates: submit certificates from plant stock vendor for each group of plant stock required, stating botanical name, common name, origin, age, date of packaging, and name and address of vendor. Submit at least 4 weeks prior to planting to the Owner and the Owner's Representative.
- C. Maintenance data: include maintenance instructions, application frequency and dosage of fertilizer, if necessary. Methods to control undesirable plant species and grazing by herbivores, such as Canada goose, white-tailed deer, beaver, and muskrat, shall be included in this submittal.

# ARCADIS

## PART 2 PRODUCTS

### 2.1 POTENTIAL VENDOR

A. Seed, Shrub, and Tree Stock

JF New  
PO Box 100  
Holt, Michigan 48842  
517.898.9018

B. Alternate vendors may be considered. The Contractor shall submit requests to the Owner for approval.

### 2.2 VEGETATIVE SOIL, FERTILIZER, AND MULCH

A. Vegetative soil, fertilizer, and mulch shall be in accordance with Section 02922 (Vegetative Soil, Seeding, and Mulch).

### 2.3 SEED MIXTURES

A. Seed mixtures for restoration areas shall contain species and quantities (by weight) as specified on Construction Drawing 9.

B. Seed mixtures shall be blended by the vendor. The ratios of the various species specified on Construction Drawing 9 shall be guaranteed by the vendor.

C. Seed mixtures will be delivered in original sealed containers. Label containers with the following information:

1. Analysis of seed mixture
2. Percentage of pure seed
3. Year of production
4. Net weight
5. Date when tagged and location
6. Name and address of vendor

D. Seeds in damaged packaging are not acceptable. Seeds shall be stored in weatherproof and rodent-proof enclosures.

E. All seeds shall have the proper stratification and/or scarification to break seed dormancy for other than fall planting.

# ARCADIS

- F. Alternate seed mixes establishing equivalent ecological communities may be considered. The Contractor shall submit the alternate material to the Engineer for review.

## 2.4 TREE AND SHRUB STOCK

- A. Tree and shrub types, height, planting density and spacing for each species shall be as specified on the Construction Drawing 9.
- B. Plants shall be free of insects and diseases and shall show the appearance of healthy growth and vigor. Root stocks shall display evidence of new growth prior to planting.
- C. All plant materials shall comply with state and federal laws with respect to inspection for plant diseases and insect infestations.
- D. Each species shall be handled and placed in a manner that is consistent with good trade practice to ensure that plants arrive at the site in good condition. Plants that arrive dried out, exposed to excessive heat or that have been in storage for extended periods of time, will not be accepted. If, upon inspection, the plants or root stocks display mold or decay, the material will not be accepted.
- E. All containerized trees and shrubs shall be at least 40 inches and 24 inches, respectively, in aboveground height container stock and have a heavy fibrous root system that has been developed by proper horticultural treatment, transplanting and root pruning.
- F. Live stakes will be dormant stem cuttings of 1/2 to 2 inches in diameter and at least 36 inches in length. Cuttings will have clean angled cuts at the bottom and flat cuts at the top, without split ends, and will have at least two live lateral buds on the portion of the stake that will be above-ground. Trim any lateral branches.
- G. All plant stock that is to be placed in saturated or flooded soil conditions shall be pre-conditioned for this placement by being held in a wet environment at the nursery prior to shipment to the site.
- H. All plant stock shall be stored in aboveground locations in non-construction areas approved by the Engineer. All plant stock shall have soil placed about roots sufficient to protect from desiccation and to provide nourishment during storage. All plants stored in the field prior to installation shall be kept cool and shall be sheltered from the drying effects of direct sunlight and prevailing winds. Plants should not be subject to freezing, drying or warming. It is the Contractor's responsibility to supply adequate water for all plant stock to maintain it in a healthy and vigorous state suitable for transplanting.

## 2.5 TEMPORARY EROSION CONTROL FABRIC

- A. Biodegradable erosion control mat shall be in accordance with Section 01571 - Erosion and Sediment Control.

# ARCADIS

## 2.6 TRANSPORTATION

- A. Transportation of the vegetative material shall be the responsibility of the Vendor. The Vendor shall be liable for all damages to the materials incurred prior to and during transportation to the site.

## 2.7 HANDLING AND STORAGE

- A. Handling, storage, and care of the vegetative materials prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the restored areas.

## PART 3 EXECUTION

### 3.1 VEGETATIVE SOIL PLACEMENT

- A. Vegetative soil material shall be placed as described in Section 02922 (Vegetative Soil, Seeding, and Mulch).

### 3.2 FERTILIZER APPLICATION

- A. Apply fertilizer to prepared riparian corridor and forested upland surfaces uniformly at the rate of 20 pounds per 1,000 square feet. Fertilizer shall not be applied to restored wetland areas.

### 3.3 SEEDING AND PLANTING

- A. Pre-Planting
  - 1. Seedbed Preparation: Shallow disc and subsequently rake the seedbed of the areas to be seeded to provide a uniform and firm seedbed, free of all live plant materials, including perennial rhizomes. If the soil is saturated, tilling may not be necessary.
  - 2. Fertilizer Application: Apply fertilizer at the prescribed rate.
  - 3. Site Evaluation: The Contractor and the Vegetation Installer shall inspect the proposed sites with the Engineer at least one week prior to the onset of field planting activities to review the condition of the site. The site condition is defined as an evaluation of soils, water levels and grades of the site in terms of conditions that are appropriate for introduction of plantings. Do not proceed with the planting program in any area until all necessary modifications and/or corrections are completed and approved by the Engineer. If other conditions that are detrimental to installation or plant growth or to the safety of the planting crew are encountered, immediately notify the Engineer prior to performing planting activities.

# ARCADIS

## B. SEEDING

1. Use seed stocks and seeding rates consistent with Construction Drawing 9. Ecologically equivalent seed mixes can be used if approved in advance by the Engineer.
2. Perform seeding within the time guidelines specified in Section 3.4 of this Specification.
3. Seed the entire restoration areas using broadcast seeding methods. Lightly rake broadcast areas within 12 hours to ensure proper soil-seed contact.
4. Where saturated soils make the use of mechanical seeding equipment impractical, hydroseeding techniques may be used with the prior approval of the Engineer.
5. Reseed areas with gaps in the areas of seeding in excess of 8 square feet.
6. Install temporary erosion control fabric over the seeded areas within the Riparian Corridor, as shown on the Construction Drawings.
7. Install straw mulch over all seeded areas that are not covered by erosion control fabric as described in Section 02922 (Vegetative Soil, Seeding, and Mulch).
8. Mark seeded areas to prevent intrusion by foot traffic and/or equipment.
9. Perform an initial watering of seeded areas at a rate of 25,000 gallons per acre, and repeat after the second and fourth weeks following seeding if natural rainfall is less than 1 inch per week. The Contractor shall avoid creating rills and furrows as a result of watering and must repair and reseed any rills and furrows resulting from over watering.
10. Hydroseeding may be accepted as an alternative method of applying fertilizer, seed, and mulch. The Contractor shall submit the Installer's experience with using hydroseeding applications specific to wetland areas and relevant data regarding materials and application rates to the Engineer for review.

## C. LIVE STAKE PLANTINGS

1. Use species, plant sizes and numbers presented in Construction Drawing 9.
2. Prior to placement of the live stakes, install temporary erosion control fabric on the prepared surface.
3. The lengths of live stakes depend upon the application. If through soil-choked stone, the length shall extend through the surface of the stone fill. At least half the length shall be inserted into the soil, below the stone fill.
4. Live stakes shall be cut to a point on the basal end for insertion into the ground.

# ARCADIS

5. A dibble, iron bar, or similar tool shall be used to make a pilot hole to prevent damaging the material during installation.
6. Use a dead blow hammer to drive stakes into the ground.
7. Live cuttings shall be inserted by hand into pilot holes. Minimum 2 to 4 inches and two live buds of the live stake shall be exposed above the prepared surface. When possible, tamp soil around live stakes.
8. Care shall be taken not to damage the live stakes during installation. The stake must not be split and the bark must not be excessively damaged during installation. Damaged stakes shall be trimmed back to undamaged condition or replaced in-kind.

## D. CONTAINERIZED TREE AND SHRUB PLANTINGS

1. Use species, plant sizes and numbers presented in Construction Drawing 9.
2. Dig holes at least 2 times the diameter and 0.5 times the depth of the plant root system to be installed at that location.
3. Remove non-biodegradable containers prior to planting.
4. Plant tree and shrub stocks by hand unless mechanical means are acceptable to the Engineer.
5. Set plants into their final locations following recommended horticultural practice for that species, taking specific note to plant species in appropriate habitats, as presented in Construction Drawing 9.
6. Plant tree species in a random spacing and in the habitat types indicated on Project Construction 9, Table 4 to establish vegetative communities. Support planted trees with two stakes and two ties looped around the trunk (not wrapped or tied).
7. Plant same shrub and live stake species in groupings of three to five individuals and in the habitats indicated on Construction Drawing 9, Table 4 to establish vegetative communities.
8. Protect trees, shrubs and live stakes from beaver, whitetail deer and muskrat herbivory with fencing, wraps or chemical deterrents. Herbivore control methods must be approved by the Owner prior to implementation.
9. Install wood chip mulch by hand around trees and shrubs to form a continuous blanket over the soil surrounding the plant, approximately 2 inches uniform thickness at loose measurement.
10. Perform an initial watering of planted areas at a rate of 25,000 gallons per acre, and repeat after the second and fourth weeks following seeding if natural rainfall is less than 1 inch per week. The Contractor shall avoid creating rills and furrows

# ARCADIS

as a result of watering and must repair and reseed any rills and furrows resulting from over watering.

## 3.4 TEMPORARY EROSION CONTROL MAT

- A. Biodegradable erosion control mat shall be installed within the riparian corridor along Willow Blvd and A-Site landfills, as shown on the Construction Drawings.
- B. Biodegradable erosion control mat shall be installed in accordance with manufacturer's instructions.

## 3.5 MULCH

- A. Straw mulch shall be installed within all restoration areas, with the exception of open water habitat and those areas covered by biodegradable erosion control blanket.
- B. Restored areas not receiving temporary erosion control fabric will be covered with straw mulch. Mulch will be hand or machine spread uniformly at a rate of 1.5 to 2 tons per acre to form a continuous blanket over the seed bed, with no greater than 2 inches in uniform thickness at loose measurement with a minimum of 90 percent surface coverage. Excessive amounts or bunching of mulch shall not be permitted. Unless otherwise specified, mulch shall be left in place and allowed to decompose.

## 3.6 ENVIRONMENTAL REQUIREMENTS OF SEEDING AND PLANTING

- A. Do not apply seed slurry when wind conditions are such that materials may be carried beyond designated areas, or that materials may not be uniformly applied, or when wind velocity exceeds 5 miles per hour.
- B. Seeding activities shall not be carried out on days with heavy precipitation that will result in washing the plantings into the body of water where they will not survive.
- C. Do not install plant life when the temperature may drop below 35 degrees Fahrenheit (°F) or rise above 90 °F.
- D. Do not install plant life when the wind velocity exceeds 30 miles per hour.

## 3.7 SEQUENCING AND SCHEDULING

- A. Schedule vegetative soil placing to permit seeding and planting operations under optimum growing conditions during normal planting seasons. Do not compact vegetative soil prior to seeding and/or planting.
- B. Seeding and planting operations shall be performed between April 1 (or as soon thereafter as the soil can be worked) and July 30. Seeding and planting may also be done from October 1 to freeze-up. Seeding and planting is not recommended between August 1 and October 1 without supplemental watering.

# ARCADIS

## 3.8 PRODUCT PROTECTION

- A. Mark seeded and planted areas to prevent intrusion by foot traffic and/or equipment. Institute measures to protect completed landscape areas.
- B. The Contractor shall use all means necessary to protect all prior work and all materials and completed work of other Sections.
- C. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary to the satisfaction of the Engineer and at no additional cost to the Owner.

## 3.9 MAINTENANCE OF RESTORED AREAS

- A. Contractor is responsible for maintenance responsibilities beginning immediately after planting and continuing through one full growing season following the year of completion of planting. Required maintenance activities for the first year will be identified based on the results of monitoring activities performed by the Contractor during the first growing season following planting. Maintenance activities will be performed by the Contractor if any of the following performance standards are not met.
- B. All planted trees and shrubs are required to be covered under warranty for one year from the date of installation. Any tree or shrub that dies within the warranty period shall be replaced with the same plant species and size originally installed, unless otherwise instructed by the Engineer. Replanting will be performed at no additional cost to the Owner.
- C. Maintenance responsibilities include the control of undesirable plant (e.g., invasive or exotic) species. Maintenance activities for undesirable plant control include mowing, physical removal and restricted hand application use of herbicides. Herbicide use shall be performed subject to the appropriate limitations of local and state regulation, including material safety data sheet review and approval of any chemicals brought on site prior to use. Maintenance of wetlands as well as all associated buffers or other habitats should address response to the species listed in Table 02921-1 below and any other species identified as a problem at the site.

**Table 02921-1: Undesirable Species**

Scientific Name	Common Name
<i>Phragmites australis</i>	Common reed
<i>Lythrum salicaria</i>	Purple loosestrife
<i>Rhamnus spp.</i>	Buckthorns
<i>Elaeagnus spp.</i>	Olives
<i>Rosa multiflora</i>	Multiflora rose
<i>Phalaris arundinacea</i>	Reed canary-grass
<i>Polygonum cuspidatum</i>	Japanese knotweed



# ARCADIS

- D. Maintenance responsibilities include control of herbivores and other vectors that threaten the establishment of a vegetative community; acts of vandalism resulting in damage; acts of nature that result in erosions, fires, wind damage, ice storms and similar situations. The Contractor shall take necessary action to correct and restore the system.
- E. At a minimum, schedule maintenance activities to support seeding and planting under optimum growing conditions during normal planting seasons, as specified above.
- F. Notify the Engineer and/or Owner prior to and following any maintenance activity.

## 3.10 CRITERIA FOR ACCEPTANCE

- A. The installed thickness of the vegetative soil layer will be assessed in accordance with Section 02922 (Vegetative Soil, Seeding, and Mulch).
- B. Vegetation will be evaluated one year following the date (as agreed upon by the Owner and Contractor) of completed construction work to determine if the vegetative growth established during this period is acceptable. The Owner and Engineer will meet with the Contractor following completion of the monitoring activities and review the restoration areas completed with a vegetative cover.
- C. All seeded areas are required to exhibit 80 percent ground cover by desirable species by the end of the first growing season. Areas or portions of areas greater than 50 square feet that do not exhibit 80 percent or greater ground cover must be reseeded at no additional cost to the Owner. Reseed or replant to maintain a minimum of 80 percent cover by non-invasive hydrophytes in emergent wetlands. Reseed or replant to maintain a minimum of 60 percent cover by non-invasive hydrophytes of which at least 15 percent are woody species in forested cover types.

END OF SECTION

## SECTION 02922

### VEGETATIVE SOIL, SEEDING, AND MULCH

#### PART 1 GENERAL

##### 1.1 SCOPE OF WORK

- A. Work under this section consists of furnishing and placing of vegetative soil, fertilizer, seed, and mulch as specified in the Project Documents.
- B. The Contractor shall perform all post-construction activities necessary for the establishment of vegetative growth as specified herein on all seeded areas until final acceptance is given by the Owner as described in Section 3.3 of this Specification.

##### 1.2 REFERENCES

- A. Section 02207 – Restoration of Surfaces
- B. American Society for Testing and Materials (ASTM):
  - 1. D4972 Standard Test Method for pH of Soils
  - 2. D2974 Standard Test Methods for Moisture, Ash and Organic Matter of Peat and other Organic Soils

##### 1.3 QUALITY ASSURANCE

- A. Quality Assurance Program: The Contractor shall agree to participate in and conform to all items and requirements of the quality assurance program as outlined in this Specification, and in the Project Documents.

##### 1.4 SUBMITTALS

- A. Analysis of the seed [to demonstrate compliance with the seed mix specified in Section 2.1(D) of this Specification] and fertilizer (to identify chemical composition), and proposed application rates [to demonstrate compliance with the fertilizer application rate identified in Section 3.1(B) of this Specification] shall be submitted to the Owner and the Owner's Representative.
- B. Should hydroseed be used, the Contractor shall submit all data including material and application rates and methods to the Owner and the Owner's Representative.
- C. Sample of proposed vegetative soil to be tested by the contractor for the chemical contaminants specified in the Project Documents.
- D. Analysis of the vegetative soil for organic content and pH.

# ARCADIS

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Any off-site vegetative soil shall be unfrozen, friable, natural material and shall be free of clay lumps, brush needs, litter, stumps, stones, and other extraneous matter. The vegetative soil shall have an organic content between 5 and 20 percent (ASTM D2974), and a pH between 5.5 and 7.5 (ASTM D4972).
- B. Fertilizer shall be a standard quality commercial carrier of available plant food elements. Fertilizer specifications will be outlined after nutrient testing of the topsoil is completed to determine the actual nutrients needs and avoid discharge of excess fertilizer components into the surface water bodies. The Contractor shall determine the appropriate fertilizer following adequate testing of vegetative soil samples and submit the proposed fertilizer material to the Engineer for approval.
  - 1. Each bag of fertilizer shall bear the Manufacturer's guaranteed statement of analysis.
- C. Seed mixtures shall be of commercial stock of the current season's crop and shall be delivered in unopened containers bearing the guaranteed analysis of the mix. All seed shall meet the State standards of germination and purity.
- D. Seed mix to be used in vegetated areas other than those subject to restoration as described in Section 02921 (Restoration Plantings) shall be: 65 percent Kentucky Blue Grass, 20 percent Perennial Rye Grass, and 15 percent Fescue. The seed mixture will be seeded at a rate of 150 pounds per acre.
- E. Mulch shall be stalks of oats, wheat, rye, or other approved materials free from noxious weeds and coarse materials.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. The vegetative soil shall be applied in a single loose lift of not less than 3 inches and shall have a final thickness as shown on the Project Documents. No compaction is required or allowed. Following placement of vegetative soil and prior to fertilizer application, all stones greater than 1-inch in diameter, sticks, and other deleterious material shall be removed.
- B. The fertilizer shall be applied to the surface uniformly at a rate that is determined by the Contractor and approved by the Engineer in accordance with Section 2.1 B. After the vegetative soil surface has been fine graded, the seed mixture shall be uniformly applied upon the prepared surface with a hydroseeder at the specified rate, unless otherwise recommended by the seed manufacturer and accepted by the Engineer.

Hydroseeding shall include application of fertilizer, seed, mulch, and tackifier. The Contractor must submit all data regarding hydroseed materials, equipment and application rates to the Engineer for review and acceptance.

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- C. Mechanical spreading of seed may be considered as an alternative to hydroseeding for select areas. The method for mechanical seed application shall include the following.
  - 1. The seed shall be raked lightly into the surface.
  - 2. Seeding and mulching shall not be done during windy weather.
- D. The mulch shall be hand or machine spread to form a continuous blanket over the seed bed, at a rate of 1.5 to 2 tons per acre with no more than 2 inches in uniform thickness at loose measurement. Excessive amounts or bunching of mulch shall not be permitted.
  - 1. Unless otherwise specified, mulch shall be left in place and allowed to decompose.
  - 2. Any mulch that has not disintegrated at time of first mowing shall be removed.
  - 3. The mulch shall be placed with a tackifier.
- E. Seeded areas shall be watered as often as required to obtain germination, and to obtain and maintain a satisfactory sod growth. Watering shall be performed in such a manner as to prevent washing out of seed and mulch.

## 3.2 MAINTENANCE

- A. All erosion rills or gullies within the vegetative soil layer shall be filled with additional approved vegetative soil, graded smooth, and re-seeded and mulched in accordance with this section.
- B. The contractor shall also be responsible for repairs to all erosion of the seeded areas until all new grass is firmly established and reaches a height of not less than 4 inches. All bare or poorly vegetated areas must be re-seeded and mulched in accordance with this Specification.
- C. The contractor shall water any vegetation if necessary to achieve acceptable vegetative growth, as defined in Section 3.3, during the one year period following the date (as agreed upon by the Owner and Contractor) of completed construction.

## 3.3 CRITERIA FOR ACCEPTANCE

- A. Vegetative Soil Thickness
  - 1. The installed thickness of the vegetative soil layer will be assessed using available survey data and may be required by the Engineer to be confirmed by test holes dug at random intervals throughout the soil cover area. The test holes will be dug by shoving of the vegetative soil to the top of the general soil fill layer. The thickness of the vegetative soil layer will be determined by measuring the depth of the test hole [i.e., from the top of the vegetative soil layer to the top of the soil

protection (general fill) layer]. The acceptable thickness will range from a 6 to 7 inches. The Contractor shall place additional vegetative soil over areas determined to have insufficient thickness. Areas of excessive thickness (i.e., greater than 7 inches) will be reviewed by the Owner, Engineer and the Contractor to determine if the excess soil quantity should be regarded elsewhere on-site or left in-place at no additional cost to the Owner in either case.

## B. Vegetative Growth

2. Vegetation will be evaluated one year following the date (as agreed upon by the Owner and Contractor) of completed construction work to determine if the growth established during this period is acceptable. The Owner and Engineer will meet with the Contractor prior to the end of the one year period and review the project areas completed with vegetative cover. Acceptable growth will be determined based on visual assessment of the vegetated areas. Criteria consider during this assessment will include evidence of stressed vegetation, areas lacking in vegetation, clumped growth and average stem density. In general, stem density will be considered acceptable if the density is viewed as being 80 percent or greater.

END OF SECTION